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ABSTRACT

This document lists science objectives for Boston elementary and middle school students. All objectives are presented in two columns. The left-hand column states each objective in general terms and gives an idea of its scope. The right-hand column, giving a specific example of what students should be able to do when the objective is achieved, serves to clarify each objective; in addition, the illustrations in this column are intended to make the objectives more vivid, suggest possible activities and sources, and break up text material. More illustrations are provided for lower than for middle grades. Objectives for kindergarten through grade 6 are divided into the same major sections: science experiences; science skills and processes; science and society; life science; human biology and health; physical science; earth science; astronomy; and science reading (with reading lists for grades 1, 3, and 5). Objectives in grades 7 and 8 focus primarily on the physical and life sciences topics respectively. Additional objectives for these grades relate to reading (with a reading list for grade 8), science experiences, science skills/processes, and other areas. A discussion of issues in science education, suggestions for teaching science, a list of 26 science goals, and (in an appendix) names of scientists/inventors are included. (JN)

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SCIENCE

Elementary and Middle School Curriculum Objectives

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SCIENCE

ELEMENTARY AND MIDDLE SCHOOL CURRICULUM OBJECTIVES

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Robert R. Spillane
Superintendent of Schools

Oliver W. Lancaster
Deputy Superintendent/Curriculum & Instruction

Kim Marshall, Program Director
Curriculum Objectives Unit

Boston Public Schools
26 Court Street
Boston, Massachusetts 02108

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MESSAGE FROM THE SUPERINTENDENT

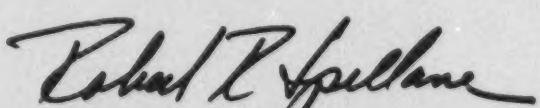
These curriculum objectives for elementary and middle school science are the beginning of a renewed emphasis on science in all of our schools. They are designed to bring about much-needed improvements in scientific literacy among our students in the years ahead. They also reinforce the curriculum objectives in reading/language arts and mathematics, and can be taught in conjunction with them. Students who are well-versed in science must also be good readers, writers, critical thinkers, and problem solvers. When these are well developed, our students will be truly prepared for the twenty-first century.

The objectives in this document are comprehensive and demanding, conveying high expectations of our students. They pose a challenge to all teachers, and to the administrators, curriculum and staff development personnel, and the universities and cultural institutions that support the work of teachers.

We must look upon the job of increasing our students' scientific literacy as a long-term endeavor in which we are all part of a single team. Our challenge is to create a cohesive, cooperative effort in each school, so that regular education, special education, bilingual, advanced work, and funded-program teachers work together with administrators, parents, university personnel, school volunteers, museums, and others to improve the achievement of all students.

While this document states clear curriculum objectives for students at each grade level, it allows considerable flexibility for teachers and principals to determine the most effective methods and materials. There must be common citywide goals and objectives, but those who work most closely with students are in the best position to decide how to convey the curriculum. Thus the purpose of this document is to harness the efforts of all school personnel in a common endeavor, and at the same time liberate the creative energy and dedication in each of our schools.

I want to thank all those who contributed to this document. It is a remarkable synthesis of previous work and current research, and represents a state-of-the-art curriculum in the field of science. It has benefited from generous amounts of feedback from numerous individuals inside and outside the Boston schools. It is this breadth of source material and input that makes the objectives so strong, authoritative, and potentially helpful in our classrooms.



Robert R. Spillane
Superintendent of Schools

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We have a wilderness of mysteries to make our way through in the century ahead.

-Lewis Thomas

The scientific method is doing your damnedest with your mind, no holds barred.

-Percy Bridgeman

Once having climbed a mountain, one's appetite for mountain-climbing tales grows.

-Michael Rossman

INTRODUCTION

Science educators consistently rank confusion and uncertainty about the goals of science education as the number one problem in the field. The purpose of this document is to present clear science goals and objectives for all Boston elementary and middle school students. The objectives state the skills and knowledge students should have mastered by the end of each grade level.

This document, like its mathematics and reading/language arts counterparts, clarifies what students should know; it is not primarily concerned with how students should be taught (although the last section of this introduction offers some specific suggestions). Decisions on methods and materials will be made by teachers, with support from principals, the Science Department, local cultural institutions, university personnel, and others.

Why the objectives were written

These K-8 science objectives were written in response to two related concerns in the Boston school community: first, that there was no citywide consistency in science curriculum that linked objectives from classroom to classroom, grade to grade, and school to school; and second, that students' science achievement was not as high as it needed to be for the increasingly technological age in which they will live and work. The current national interest in science and mathematics education only reinforced this concern. The objectives are designed to accomplish six things:

1. Validate the teaching of science in elementary and middle schools
2. Provide some basic citywide uniformity in content and processes, so that the same basic material is taught to all students at each grade level (this includes bilingual and special needs students), with flexibility as to the methods and materials used
3. Give teachers a precise idea of what is worth teaching and learning in elementary and middle school science
4. Give parents and students an idea of what is expected at each grade level
5. Make internal and external staff development activities more productive by giving everyone a common frame of reference
6. Provide a starting point for the gradual upgrading of science education over the next four or five years.

How the objectives were developed

Many educators inside and outside the Boston school system have developed curriculum objectives in science. Rather than re-inventing the wheel, we drew heavily on previous work. Among the resources were:

-previous Boston science curriculum documents
-exemplary science curricula from other school systems around the U.S.
-professional literature on science education
-interviews with science educators in the Boston area
-a sampling of recent textbooks and programs in K-8 science

A preliminary draft (minus the right-hand column) was circulated to a selection of teachers, administrators, parents, and science educators for comments (see Acknowledgements). In June, 1983, 3000 copies of a revised draft (still without the right-hand column) were distributed to all Boston elementary and middle school science teachers, and to interested parents, administrators, and science educators, for further comments and suggestions. Nearly 1000 response sheets were received, tabulated, and analyzed. The response to the draft was largely positive, but there were many specific criticisms and suggestions. Over the summer, a substantial number of changes were made. Then, with the help of a consultant and an illustrator, the right-hand column was completed, and the near-final draft subjected to one more round of scrutiny by proofreaders and science experts.

Minimum and maximum curriculum - the circled objectives

The material in each grade level's objectives is geared to what is generally expected in schools across the country, and generally reflects the content of many textbooks and other instructional materials. Commercial programs and school curricula generally lay out much more than teachers can reasonably cover in a year. Our purpose is to set forth a realistic core curriculum, with enrichment material clearly defined as such. Teachers should have ample objectives to handle the individual differences in their classrooms.

The objectives for each level are both a maximum and a minimum curriculum. The total list of objectives is ambitious, reflecting very high expectations of our students. Nested within this maximum curriculum is a set of minimum essentials. These priority objectives, which are circled, are those that all students should master.

Decisions on which objectives to circle were based largely on responses from teachers to the June, 1983 draft. Teachers' responses to individual objectives fell into three categories: they could circle an objective, indicating that they thought it was essential for that grade level; they could cross the objective out, indicating that they thought it was inappropriate; or they could leave the objective unmarked, indicating that they thought it was an acceptable but not essential objective. The following standard was used to decide which objectives to circle: if 40% or more teachers circled an objective, and 25% or fewer crossed it out, the objective was circled, based on a 75% positive rating. If 40% or more said an objective was inappropriate, it was either revised, moved to a higher level, or dropped. In a few cases, exceptions to this rule were made to maintain continuity in strands running through grade levels. Below is the number of circled objectives and the total number of objectives at each grade level.

	objectives	circled
Kindergarten	46	36
First Grade	67	47
Second Grade	103	63
Third Grade	100	68
Fourth Grade	129	87
Fifth Grade	160	98
Sixth Grade	172	97
Seventh Grade	151	105
Eighth Grade	111	103

The two-column format

All objectives are presented in two columns. The left-hand column states each objective in general terms and gives an idea of its scope. The right-hand column gives a specific example of what students should be able to do when the objective is achieved. The right-hand column serves to clarify each objective, and can be a model for teacher-made tests and assessments. It will also be the blueprint for citywide competency tests and checklists that will be developed over the next few years. The left-hand column almost always contains the answer to specific questions asked in the right-hand column. In a few cases, the right-hand column has suggested ways of teaching an objective or presented an enrichment activity.

In science (unlike mathematics and reading/language arts) the right-hand column is closer to being a teaching tool. Questions designed to see whether students have learned an objective can also be used to help them learn the material. The specific right-hand column questions can be used as part of the process of getting students working on projects and looking up information in reference books. One possibility is a science "question of the day" which challenges students to find a piece of information or knowledge.

The illustrations in the right-hand column are intended to make the objectives more vivid, suggest possible activities and sources, and break up the text. There are more illustrations in the lower grades than in the middle school grades.

The philosophy underlying the objectives

Any set of curriculum objectives, whether it admits it or not, is based on a philosophical position on the issues in that subject area. In science education, there are on-going debates about what is worth knowing and how children should be taught. This document, despite its "hands-off" posture on the how of instruction, cannot help but become involved in these pedagogical issues. Below is a summary of the policy conclusions implicit in these objectives. (For a fuller discussion of the thinking behind these conclusions, see the following section, "Issues in Science Education.")

1. Science curriculum in each classroom should be guided by a set of citywide objectives, and backed up by competency tests and teacher-observation checklists (after adequate materials and the proper staff support are in place).

2. The objectives should be assessed by a combination of curriculum-referenced tests and teacher observation of the objectives that cannot be tested in a paper-and-pencil test.

3. Hands-on science experiences are crucial, both as an effective way of learning basic science and as a way of learning about how science works (thinking and problem-solving skills). But it is not practical to base an entire curriculum on hands-on experiences. Accordingly, the curriculum builds in a minimum requirement for hands-on experiences, and relies on intensive staff development over a period of years to help more teachers move in this direction.

4. There is a body of knowledge that is important for students to learn; it includes important factual information and the skills and processes of science, and can be spread out over the grade levels so that children emerge from middle school with a broad base of scientific literacy.

5. Students' interest and personal involvement in what they study in science is an important ingredient in how much they learn and how motivated they will be to continue studying and applying science.

6. Teachers should not be locked into one program or textbook; rather, they should be given clear objectives and encouraged and supported in putting together an eclectic mixture of approaches and materials, with the emphasis on high quality materials with which they are comfortable. This leaves open the possibility of staffs adopting programs for school-wide use.

7. Any textbooks that are used should be of the sort that help teachers find hands-on ways of teaching basic content material.

8. Classroom materials, whether textbooks or manipulatives, should be supplemented with plenty of other reading matter, including trade books and magazines, and by other experiences - field trips, visiting speakers, etc.

9. Hands-on experiences should not be dependent on elaborate and difficult-to-maintain equipment; as much as possible, these experiences should build on simple, everyday items that are easy to obtain (paper clips, shoeboxes, marbles, candles, bread, clay, string, scraps of wood, etc.).

10. We should focus on the quality rather than the quantity of science learning. A few well-learned pieces of factual knowledge are more helpful than many superficially-memorized tid-bits of information; one really good hands-on experience is better than ten experiences that are not well-planned or exciting to the student. Getting students to the point where they are not afraid to ask questions - even questions that seem "dumb" - is more important than rote memorization.

11. Students should have the opportunity to work alone, in small groups, and in large groups.

12. There should be on-going support for teachers from colleagues, principals, staff developers, university experts, and consultants.

This translates into certain basic experiences that students should have between kindergarten and eighth grade:

- Each year, children should have at least one hands-on science experience involving the basic skills and processes of science. These experiences can take several weeks, be carried out alone or in small groups, and can tie into student presentations at school and citywide science fairs.

- Each year, children should become immersed in at least one topic of their own choosing (anything from spiders' webs to dirt bikes) and present a report. This project can tie into experiments, field trips, interviews, reading, and work in other subject areas.

- Each year, children should acquire basic knowledge in the areas of Life, Physical, Earth Science, Astronomy, Human Biology and Health, and Science and Society. There should be a good balance between these areas from Kindergarten through sixth grade, giving way to specialization on Physical Science in seventh grade and Life Science in eighth.

- Each year, children should read a number of excellent children's science books.

Accordingly, each level from kindergarten through sixth grade is divided into the same major sections. They are:

A. Science Experiences
B. Science Skills and Processes
C. Science and Society
D. Life Science
E. Human Biology and Health
F. Physical Science
G. Earth Science
H. Astronomy
I. Science Reading

The objectives for kindergarten through sixth grade cover a mixture of Science Experiences, Science Skills and Processes, Science and Society, Life Science, Human Biology and Health, Physical Science, Earth Science, and Astronomy. The substance of each section is arranged in these strands through the grades, with content and skills placed at the level where they seem developmentally appropriate. There is a fair amount of overlap from grade to grade, with material presented in a gentle spiral that builds on previous knowledge and skills.

Seventh and eighth grade focus

The seventh grade objectives focus primarily on Physical Science, the eighth grade on Life Science, in each case leaving out the other content strands (except for Human Biology and Health and Science and Society). This sequence has been customary in Boston middle schools for some time, and was strongly affirmed in the fall of 1983, when 19 out of 24 middle schools expressed a desire to maintain the Physical/Life sequence rather than changing to the Life/Physical sequence suggested in an earlier draft of this document. The rationale for maintaining this sequence is as follows:

- Physical Science lends itself more readily to hands-on experiments, and direct experience with materials is especially appropriate for younger students.
- The hands-on experiences involved in Life Science (especially dissections) are more appropriate for older students.
- Having Life Science closer to tenth grade Biology I leads to greater carry-over of knowledge than would be true if Life Science were studied in seventh grade.

Thus the K-12 sequence (including elective courses in high school) looks like this:
K-6th grade - General Science
7th grade - Physical Science
8th grade - Life Science
9th grade - Earth Science
10th grade - Biology I
11th and 12th grade - Chemistry, Physics, Physical Science, or Marine Science

Book lists

At four points in the document (first, third, fifth, and eighth grades) there are extensive lists of highly-rated science books. The lists were compiled from a variety of sources by Boston's head librarians and outside experts on children's science books. Reading about science is a priority objective at each level of the curriculum, and the lists are intended to be a major resource for teachers. Excellent children's science books can be a significant part of the print curriculum in Boston classrooms, replacing more conventional (and perhaps less interesting) textbook material and forging links between science and reading/language arts instruction.

Our original intent was to have annotated book lists, but this proved impossible for reasons of time and space. A separate document with annotations of all books K-8 may be published in the future.

Health and sex education

Objectives in health are part of the section on human biology at each level; the two subjects are so closely related that separating them into two separate curriculum documents seems illogical. Although health may not be taught by the same teacher who teaches science, the objectives are included in this document to encourage the greatest possible integration of the two subject areas.

Objectives in sex education are being developed separately and will be taught as part of the health curriculum when issues such as School Committee approval, teacher training, and parent permission have been resolved.

Competency tests

Citywide tests geared to the curriculum objectives for each course will eventually be important to the science curriculum objectives, especially in giving science parity with mathematics and reading/language arts. Written in the central testing office and accompanied by observational checklists for the objectives that can only be assessed by teacher observation, these tests will be directly based on the objectives for each grade, so that teachers and students know exactly what will be assessed (without, of course, knowing the precise content of each test). These citywide competency tests will replace classroom and school-level final exams in science.

English versus metric measurement

Although some science educators believe that only metric measurement should be introduced from the early grades, this document follows the approach taken in the Boston mathematics curriculum objectives. The full adoption of metric measurement by the United States is far from certain, and in the mean time, it is important that children be "bilingual" in the English and metric systems by the time they reach middle school. Exactly paralleling the mathematics sequence, English measurements are introduced in the primary grades, with metrics phased in during the fourth and fifth grades.

What curriculum decisions remain in teachers' hands?

The objectives in this document clarify what Boston students should understand and be able to do at the end of each year of science teaching. But the most important decisions - those that determine how much students learn - cannot and should not be made by a central office document. Below is a list of some of the decisions that teachers (supported by principals, the Institute for Professional Development, the Senior Advisor for Citywide Science Programs, university experts, and others) should make:

-Readiness and review - giving students the foundations they need to move on to more advanced work

-Instructional sequence - deciding on the best order to teach material

-Blending - finding ways to mix objectives from different parts of the curriculum, combining objectives within science areas (life, physical, astronomy, etc.) and relating science with instruction in other subject areas (reading, writing, and mathematics) in effective multi-disciplinary units

-Materials - seeking out the most effective hands-on materials, print material, overhead transparencies, films and filmstrips, and classroom activities to convey the citywide objectives to students

-Field trips - beyond the systemwide field trips to the Museum of Science in the second and fifth grades, additional trips to the Museum and other sites can enrich the curriculum

-Enrichment - deciding how many of the uncircled objectives to include for which students, and considering other extensions of the objectives

-Relevance - finding ways to make science applicable to students' everyday lives

Science fairs

The A strand at each grade level (Science Experiences) lends itself to having students prepare projects and experiments for school, district, and citywide science fairs. Students working on the A-1 and A-2 objectives can be fulfilling several objectives from the content strands as well, and, in addition, be preparing an entry for science fairs.

What follow-up will there be to the publication of objectives?

Citywide curriculum objectives are only the first step in a larger curriculum effort. They will be followed up by:

- A revised policy on time allocations which substantially increases the weekly time to be spent on science
- A listing of the resources available from local cultural institutions, along with their relevance to each part of the science objectives

- A systematic evaluation of science materials - print and non-print - to find those that most effectively help teach our objectives. Boston does not plan to "adopt" one program or textbook series; rather we plan to give teachers excellent "consumer information" on available curriculum materials to help them make the best decisions at the school level that are consistent with the citywide objectives.
- Opportunities for teachers to share effective materials and practices
- Support and training for teachers in areas where help is needed, in the form of workshops, courses, and in-service sharing
- Regular professional updates on developments in the field of science education

ISSUES IN SCIENCE EDUCATION

Science curriculum has been a low priority in many school systems in recent years. Relatively few students go on to careers in science and technology, and there is a common perception that science is only appropriate for certain students who are inclined in that direction. Until very recently, science has not been considered one of the "basic" subjects; it has not received the instructional time and support usually given to reading, writing, and mathematics.

Science education in the Boston schools has been in serious decline, particularly in the elementary grades, since a cadre of support personnel was laid off in the budget cutbacks of the late 1970's. These individuals had made possible the implementation of SCIS (a set of science kits) and other science programs stressing hands-on activity. As a result, many of these materials have been in disuse, and teachers are no longer being trained in large enough numbers to get optimal use out of the materials in the school system.

But in recent years, increasing numbers of educators and parents - both in Boston and across the U.S. - see scientific literacy as one of the most important outcomes of education. There is a growing belief that <u>all</u> children need exposure to science to be prepared for their lives in the twenty-first century. There is also growing evidence that the content knowledge gained in science classrooms has an important carry-over to reading and mathematics achievement.

The purpose of this introduction is to spell out this demand for a more rigorous science curriculum, by answering the most basic questions: What is science? and Why should we teach it at all?

What is science?

Science often seems like an intimidating and august body of knowledge. But we do well to keep in mind that most scientific fields are relatively young, and some (especially biology and geology) are undergoing rapid change. As Lewis Thomas wrote recently:

> On any Tuesday morning, if asked, a good working scientist will tell you with some self-satisfaction that the affairs of his field are nicely in order, that things are finally looking clear and making sense, and all is well. But come back again on another Tuesday, and the roof may have just fallen in on his life's work. All the old ideas - last week's ideas in some cases - are no longer good ideas. The hard facts have softened, melted away, and vanished under the pressure of new hard facts. Something strange has happened. And it is this very strangeness of Nature that makes science engrossing, that keeps bright people at it, and that ought to be at the center of science teaching.

This document defines science in the broadest fashion. Science is:

1. The gathering and organizing of knowledge to explain what can be observed and tested in the world around us

2. A search for the fundamental laws that apply in all times and places

3. A set of processes and skills, and an inquiring and iconoclastic attitude, that can be used to acquire and compile information in a systematic way

4. A process of constantly verifying and re-checking, so that invalid theories are cleansed from the body of scientific knowledge (as Richard Feynman has written, "Science is the belief in the ignorance of experts.")

By this broad definition, science is almost everywhere. It is in the kitchen, in the garden, in the supermarket, at the gas station, and in many current news events. Science is also buried in a set of skills and thinking processes - observing, measuring, classifying, hypothesizing, predicting, graphing, etc. - that reach into all walks of life. Many teachers and students may be surprised at how much of what they have been doing in other subject areas is really science.

There are a number of characteristics of scientific knowledge that make it especially important for children. It is generally:

- tentative, constantly subject to change, with no claims on absolute and final truth

- cumulative, today's knowledge building on yesterday's discoveries (even if previous knowledge contained errors)

- testable or observable, which is what differentiates science from the occult and the mystical

- replicable, meaning that others must be able to get the same results using the same materials in different places and times

Why teach science?

There are powerful reasons for a strong science curriculum. Here is a summary of that rationale:

1. Science helps children make sense out of their world and feel more at home amid its wonders, its problems, and its constant changes. Children should emerge from a good science education feeling less intimidated by the technological world around them, and more in control of their lives.

2. Science helps students become more adaptable to a constantly changing world; science is a key to "learning how to learn."

3. Science is an excellent way to learn basic skills: reading, writing, listening, speaking, computing, problem-solving, and critical thinking are all part of an effective science curriculum.

4. Science is an excellent way to gain background knowledge for further education and reading.

5. Science education trains the next generation of professional scientists, physicians, technicians, and engineers, on whom much of our productivity and well-being depend; even if many of our students opt for other fields, those who do enter scientific fields will be greatly influenced by the presentation of science in elementary and middle schools.

6. The skills and values of science (often called "the scientific method") are in fact generic skills applicable to other subjects and to all walks of life. The scientific method is nothing more than the total application of human intelligence to problems (see the Percy Bridgeman quote at the beginning of this document). Some attributes of this approach are:
   -a constant search for knowledge and explanations
   -a willingness to question and re-examine everything, to ask the most fundamental questions (even if they seem like "silly" questions)
   -a constant effort to free oneself from preconceptions
   -the ability to observe and measure carefully
   -the ability to formulate hypotheses and make predictions
   -the ability to design and carry out experiments
   -the ability to use logical, step-by-step thinking
   -reporting information in an honest and unbiased way
   -a willingness to communicate results openly
   -an insistence on verification of information and theories; submitting findings to the scrutiny of others
   -the willingness to suspend judgment, seeking out evidence before jumping to conclusions
   -a respect for logic

7. Science helps students become better decision-makers about current scientific issues in which moral choices are necessary (wilderness conservation, pollution control, highway safety, urban planning, population control, DNA research, nuclear armaments, etc.).

8. Science helps children rely less on so-called authorities and more on their own judgment.

9. Science helps children become more critical thinkers, so they can tell sense from nonsense (looking critically at astrology, superstitions, tarot cards, cults, gurus, psychics, faddist nutrition, etc.)

10. The high points of scientific discovery (Newton's laws of motion, the discovery of penicillin, the exploration of the structure of DNA, etc.) are basic knowledge, every bit as important as major historical events, and literary, musical, and artistic works.

11. Science can be a major source of personal enjoyment. As Jerrold Zacharias wrote recently, "...a student who has never felt the beauty of a simple experiment in science or of an elegant proof in mathematics is missing a major aesthetic pleasure."

12. Science helps to nurture, sustain, and satisfy children's fascination and curiosity about the world around them.

A RECENT HISTORY OF SCIENCE EDUCATION

Elementary science teaching has always posed major challenges to American educators. There has been great disagreement about what to teach, how to teach it, how to overcome the lack of specialized training in science among many elementary teachers, and how to deal with the low status of science as compared with the "basic" subjects, reflected in the lack of classroom time, materials, and facilities allotted to science in most schools.

In the 1960's and before, textbooks dominated science instruction; a 1961 study showed 82% of primary teachers and 95% of intermediate teachers depended mostly on textbooks. These books were mainly expository, with hands-on experimentation optional.

The new "hands-on" curricula

Then, spurred by Russia's successful launching of Sputnik in 1957, the National Science Foundation (NSF) gave a $400,000,000 boost to science education, spawning a series of new curricula: SCIS (Science Curriculum Improvement Study), ESS (Elementary Science Study), SAPA (Science - A Process Approach), and others. The developers of these new curriculum packages believed that the only way for children to develop science skills and understand concepts was through direct, first-hand involvement with materials. Rather than building their curricula on what they considered the shifting sands of content in dreary textbooks, the program developers aimed to explore the deeper processes of science and give children the same kind of experiences that real scientists have.

So the NSF programs cast aside the textbook as a means of conveying scientific knowledge and built programs largely around manipulative materials. SCIS, ESS, SAPA, and other NSF materials had few print materials, which made them independent of students' reading level. The teacher went from being the center of attention (lecturer, discussion leader, and demonstrator) to being a questioner, a listener, and a suggester. Where textbooks had emphasized memorization of considerable bodies of knowledge, the NSF materials stressed higher cognitive skills and an appreciation and understanding of the nature of science through inquiry, discovery, open discussion, creative thought, and problem-solving. They drew heavily on skills that had formerly been reserved for English, reading, and mathematics. They also mixed the traditionally separate areas of life, physical, and earth science.

The decline of the NSF programs

But after an initial surge in popularity in the 1970's, which brought the new materials into about 20% of elementary classrooms, the NSF materials began to run into serious difficulty. At present they are used in very few classrooms. Boston, which adopted SCIS in the 70's, has been part of this national trend, with many of the elaborate kits now gathering dust in supply closets and many SCIS-trained teachers reverting to previous methods.

A recent study of the effectiveness of the NSF programs turned up very positive results: compared to pre-1955 textbooks, the NSF programs produced higher student achievement (with urban, less advantaged, and female students making the biggest gains); improved attitudes toward science; and impressive improvements in the process skills, problem-solving, and critical thinking (Shymansky, et al., 1982). So why the move away from the NSF curricula?

There seem to be several reasons, some related to the materials themselves, some to other factors in the schools:

1. Logistics It was difficult for many teachers to manage, store, and keep inventory of the manipulative materials and replenish the kits when pieces were lost, broken, or used up. The kind of support system needed to keep the kits operational was lacking in many school systems.

2. Cost The NSF materials, and the staff training needed to make them work, were more expensive than textbooks.

3. Revolutionary pedagogy The NSF materials required major changes in the way teachers functioned in the classroom - the shift was from teacher-centered to student-centered instruction. In many cases the extensive staff training needed to convince and equip teachers to make such a change was not funded or sustained.

4. Newness and complexity Many teachers were unfamiliar with the methods, equipment, and vocabulary of the new materials and somewhat intimidated by the general approach. This was especially true of new teachers without science backgrounds who missed the original staff training. Many of these teachers felt more secure with textbooks.

5. Preparation time The NSF materials required a good deal more teacher preparation than textbook programs; for some hard-pressed teachers, this made them unacceptable, especially if the necessary support from principals and staff development personnel was lacking.

6. "Teacher-proof?" In trying to give teachers the objectives, materials, and methodology all in one package, the NSF developers neglected the importance of teachers' ownership of the curriculum they were being asked to teach - of the need for teachers to feel some control over and flexibility with curriculum materials. A good many teachers felt that the NSF materials did not leave them enough professional flexibility.

7. Lack of reading matter Most of the NSF materials lacked print materials in which students could use reading skills to learn science processes and content knowledge. This became more of a difficulty as the "back-to-basics" movement led educators to place more and more emphasis on reading.

8. Conceptual difficulty It seemed to many teachers that the NSF materials were geared primarily to upper-ability students, while students who were not highly motivated in science and mathematics had difficulty and became discouraged.

9. Student learning Many educators believed (especially as the "back-to-basics" movement took hold) that students were not learning as much basic science in the NSF programs because of the focus on hands-on activity. As the recent study has showed, this was untrue. But in the climate of the late 70's, children reading textbooks and watching demonstrations looked more serious than students "playing around" with manipulative materials. (Perhaps the purchase of white lab coats for all students and teachers using NSF materials would have made a difference.)

10. Little emphasis on technology The NSF materials did not emphasize the applications of science in technology, focusing instead on the deeper science processes. The 1980's brought an explosion of popular interest in technology - computers, space travel, ecology, energy, nuclear issues, and other "high tech" applications of science. Ironically, the NSF programs were not geared to satisfying this demand among students.

11. New "hybrid" textbooks Some publishing companies studied the NSF materials and learned from them, producing a new generation of textbooks that included a heavy emphasis on hands-on learning. These new textbooks are an attractive alternative for teachers who have had difficulty with the NSF materials but are committed to their goals.

For these reasons, there has been a major decline in the use of the NSF materials, and textbooks are once again the overwhelming choice of teachers for elementary as well as middle and junior high school science programs.

Content knowledge versus process skills

The debate over the NSF materials highlighted two issues that have always divided science educators: First, how important is it that children have hands-on experience as they learn science? And second, how important is content knowledge (versus experience with science processes) in scientific literacy?

On the first issue, there is little disagreement; virtually all science educators believe that students should have as much direct experience with manipulative materials as possible (more on this later). But on the second issue - the knowledge children should acquire - there is considerable disagreement.

There are really two kinds of science on which curriculum can focus: product (the organized, systematized body of verified knowledge about the natural world, a record of what has been discovered); and process (how scientists go about exploring, searching, discovering; the thought processes for acquiring knowledge).

Science educators who see the main goal of the curriculum in terms of the processes of science contend that what is important is not factual knowledge about scientific principles, theories, and laws, but the deeper thinking processes that can be applied to science and other areas of life; problem-solving tools for making sense of a constantly changing world. The most extreme advocates of process curriculum assert that content is irrelevant, and should depend on students' interests and teachers' preferences. These educators are convinced that if specific content knowledge is mandated in a curriculum, students will be led to memorize it and will miss out on the essence of science. Process advocates further assert that content knowledge is constantly changing, and to build a curriculum on it is to place it on unstable foundations. What children need, they say, are the general skills to be able to make sense of the new and emerging content knowledge of the next century.

But while it is essential that students have direct experience with the processes of science (rather than merely reading about them), there is a significant body of scientific knowledge that children need in order to be scientifically literate - and very little of this knowledge base can be

acquired by direct hands-on experience.

A balanced science curriculum must have direct science experiences, but it must also have a good master list of content information to be conveyed to students at each grade level in a variety of ways - hands-on experience, teacher demonstration, field trips, student presentations and projects, and extensive reading. There are many crucial concepts and facts about the universe which children need to know to make sense of the world around them - how their own bodies work, the basic principles of heredity, the scientific theory of evolution, some of the basic laws governing matter and energy, the arrangement and movements of the solar system, and so forth. We simply cannot take for granted that our students will pick this information up from other sources, or that, if they do, their information will be correct. There is a great deal of "non-science" gaining currency in our society (astrology, tarot cards, UFO's, etc.), and children need a strong base of scientific information (as well as critical thinking skills) to be able to confront the myths and half-truths that constantly assault them.

To be sure, some of this scientific content knowledge will change in years to come. But that does not mean that children should not learn the current state of the art, along with the fact that all scientific knowledge is tentative. Children will be better equipped to understand the inevitable changes in today's "facts" if they know a lot of current information and are familiar with the structure of current beliefs.

Extensive factual knowledge about a wide range of topics will also help students in other areas - in reading, writing, social studies, and even mathematics classes, and in the outside world. Recent studies in reading have shown that one of the most important factors in successful reading is prior knowledge of the subject matter: the more knowledge students have, the better they read. And that knowledge must be learned somewhere.

Of course students' learning of the facts and concepts of science need not be a boring process of memorization or be divorced from what interests them. In fact, one of the best strategies for acquiring information is having students pursue a topic of interest and acquire great quantities of factual information on it, and then share that information with classmates.

Reasonable people can disagree on what factual knowledge students need to acquire. But those who say, "It doesn't matter what children learn..." make it sound as though acquiring content knowledge is not important. However, if that statement continues "...but the more they learn, the better!" it captures the need for children to have a broad information base - and opens the way for teachers, parents, and science educators to debate just what is worth learning.

It does matter that children know a lot about science so that they have the prior knowledge to build upon and to which they can relate new information. It does matter that a school system spells out clear content expectations in science, because learning goals that are not clear cannot be high (and high expectations are crucial to student learning). It does matter that students move from grade to grade with certain predictable information and experiences, making it possible for each new level of teachers to build on what came before. It does matter that the knowledge is intelligently spread

out through the grade levels, presented in a logical sequence, and offered at the developmentally appropriate point. And it does matter that the information children learn is up-to-date, and is accompanied by the proper cautions on its changing nature.

Thus the quite proper drive in the NSF materials for process experiences must be supplemented in the post-NSF era by a similar drive for extensive scientific knowledge. A balanced curriculum should include process skills, a good array of core information at each grade level, and then leave plenty of flexibility for students and teachers to expand on that core knowledge base according to their own interests and the materials they have available.

Are objectives appropriate in science?

There has been great resistance to behavioral objectives among some science educators. Their feeling is that objectives:

-stifle the real spirit of science
-keep teachers and students from pursuing topics of personal interest
-lead to rote memorization of facts and principles rather than real science experiences
-lead teachers to wear objectives like blinders and overemphasize low-level skills that are easiest to measure
-stifle interest and creativity, and turn science into a chore.

Yet it is hard to find other viable ways of upgrading the low estate into which science curriculum has fallen in the Boston schools. Mandating five periods of science teaching a week is not the answer. Mandating an NSF program is not the answer, given the implementation problems cited above. A mandated textbook series would be resisted by teachers, many of whom feel professionally insulted if they are not given a voice in the selection of materials. The lack of alternative strategies points to curriculum objectives as one of the only ways validate and propell an upgrading of science education.

The lack of clear citywide objectives has been one of several factors in the eclipse of science in the Boston schools. The major emphasis given to mathematics and reading has pushed aside science curriculum in recent years. This and other factors have led to the perception that science is not an important subject. Unless there are objectives and accountability in science as explicit as thosse in reading and mathematics, this downgrading of science will continue.

A lack of grade-by-grade requirements has also made it extremely difficult for each teacher to see the limits of his or her responsibility. Without clear guidelines for each grade level, students do not enter each year with a predictable body of knowledge and skill, and each teacher feels called upon to teach the entire curriculum - heroics that lead to burn-out and frustration. A coherent set of K-8 objectives should give teachers some confidence that students will enter their classrooms with certain skills and information, and assure them that their responsibility is finite. It should also help teachers feel part of an overall K-8 effort.

So citywide objectives can provide valuable structure and orderliness for teachers, and be a factor in getting science taken more seriously. Objectives can also give good "consumer information" to students and parents about what our intentions are, and can serve as a predictable basis for evaluation by spelling out in advance what is going to be tested at each grade level.

At the same time, objectives can leave to teachers the all-important decisions as to how the material will be taught. And clear objectives can help teachers in their selection of methods and materials. It is easier to channel creativity into effective lesson planning when the basic curriculum objectives have been laid out by someone else. Objectives also pose a challenge to staff development people: convince teachers of the validity of certain approaches; help them move in the direction of more effective instruction.

The behavioral objectives in some other school systems have narrowed the science curriculum and brought about some of the feared results. But not all objectives have to be this narrow. It <u>is</u> possible for objectives to include process skills, hands-on experiences, personal choice, open-ended investigation and reading, and something of the spirit of science. Our hope is that the objectives in this document provide a structure for great improvements in science education. Of course a central office set of objectives can only provide a limited amount of help to teachers, and must be followed up by staff support and materials; but it is an indispensible first step to getting science education moving again.

TEACHING SCIENCE - SOME SUGGESTIONS

Although the primary purpose of this document is to set objectives and leave the actual process of instruction to teachers, the section below offers some suggestions on approaches to science teaching that may prove useful.

One of the most important messages from science educators in the last twenty years is that direct experience with hands-on materials is essential if children are to: (a) achieve the broader goals of science, and (b) remain interested in the subject matter. A few simple experiences - not requiring elaborate equipment - can achieve more than thousands of words of explanation.

But many teachers remain skeptical about the value of hands-on materials; the realities of classroom management and preparation time prevent many from moving away from the traditional "stand-up" teaching of science. The "back-to-basics" movement has pushed many school systems away from manipulatives in science classrooms. Teachers who are made to feel anxious about test scores are less likely to experiment with methods and materials that they consider less than sure-fire.

All this flies in the face of strong evidence that hands-on science teaching conveys basic information (as well as the processes of science) more effectively than lecture/textbook teaching. Children who have a direct experience with a topic are more likely to do better on standardized tests than students who used rote memorization. It will always be possible to get children to store facts in their short-term memories and regurgitate them on demand; but such learning is easily forgotten and seems to contribute little to children's understanding of the world. One does not really learn science - much less become scientifically literate - by committing long lists of facts to memory. What memorizers are learning are science <u>words</u>, not science.

Any objective in this document can be taught in a number of different ways. In virtually every case, the more vivid and direct the methods of teaching, the better students will learn the objective, and the more it will mean to them in the future. The more hands-on the approach, the more likely it is that students will achieve a deep knowledge of science that they can apply to real-world situations, rather than a superficial, test-oriented knowledge. What should not happen is direct teaching of the objectives; they are end points toward which teaching should be aimed, not actual classroom lessons.

Another reason for maximizing hands-on learning is that science begins to take on an air of magical unreality if children only read about it and watch demonstrations and films rather than "doing" science themselves. We want science to be real, not magical - and this cannot be accomplished by using books alone.

All this points to the supreme importance of getting students in touch with materials and with their environment, testing and manipulating real "stuff;" of teaching science topics in relation to each other and to other subjects. Students need to carry out investigations, projects, and experiments. As much as possible, they need to figure things out for themselves - re-invent scientific wheels - so they get a sense of how basic theories and principles came about. As much as possible, science should be an open-ended,

tentative process in which students have more questions when they finish than when they began. Above all, science should not be drudgery, but rather an enjoyable, satisfying process that children will want to continue in high school and everyday life.

All that aside, teachers should not be made to feel guilty every time they don't teach a topic with a brilliant hands-on lesson. Hands-on science is more difficult, and it is not always possible or even desirable to teach science with manipulatives. Giving students hands-on experience with science can consist in letting them get their hands on excellent science books, or telling them exciting stories of how scientists made important breakthroughs, or relating scientific topics to children's everyday lives. Good science teaching covers a broad range of experiences, from the theoretical to the experiential. Our job is to find the approaches that do the most effective job of conveying skills and content knowledge to our students, given the constraints of each classroom and school. This amounts to a massive instructional challenge, and this curriculum document is only the first step toward the ultimate goal.

Below are some more specific suggestions:

1. Kill several birds with each lesson Think of science teaching in conjunction with other subject areas. Science objectives in measurement, observation, description, vocabulary building, report-writing, reading, mapping, following directions, and problem-solving all overlap with other subject areas (see Appendix A, which lists objectives from other curriculum guides which overlap with science at each grade level). It is possible to cover science, reading/language arts, social studies, and mathematics objectives in a single lesson or project. In fact, science objectives can give students something real to calculate, measure, and write about. This kind of overlapping is the most desirable approach to Boston's voluminous and challenging curriculum objectives, especially the writing and thinking objectives. Skills and content should not be taught as isolated bits of information, but as an integrated whole.

2. Let children figure things out for themselves whenever possible We educators have a strong tendency to give students answers to questions that they have not yet asked, and to answer students' questions too quickly ourselves. One of the most powerful teaching tools in science (as in other areas) is students' curiosity, and we need to exploit that quality for all it's worth. This means raising topics and then holding back and letting students ask questions, then waiting a little longer and letting students answer some of their own questions through discussion and research. Perhaps the most frequent teacher questions should be "How do you know?" and "How can you find out?" Students should feel that there is no such thing as a "stupid" question; they should feel they can ask the most basic questions in the course of their work.

3. Respect and deal with children's naive and mistaken theories Recent research has shown that unless parents and teachers take seriously children's often mistaken theories of how the world works, and make sensitive efforts to counter these theories with real evidence, children will cling to them through the most thorough science curriculum.

4. Turn your classroom into a small science library Each classroom should have an abundance of children's science books and magazines readily accessible, whether they are on loan from the library or in the form of a classroom collection. Students should be constantly exposed to a wide variety of written and pictorial information on a range of science topics - not just those covered in that grade level's objectives.

5. Let students learn from each other's work Use students' individual projects and reports as a curriculum resource in the classroom. Children are more likely to read and listen to a report on magnets or black holes or gorillas from a classmate than in a textbook. When students present their projects to an immediate audience, they will be more eager to produce their best work.

6. Use variety The greater the variety of formats teachers use to convey science objectives, the better. These include student projects and presentations; reading books, magazines, newspapers, and textbooks; using films, overhead transparencies, filmstrips, television programs, and tape recordings; covering bulletin boards and walls with posters, pictures, and students' work; setting up learning centers; putting on pantomimes, plays, dramatizations, games, and simulations; going on field trips, including excursions to the school yard; inviting guest lecturers; staging debates and panel discussions; taking schoolwide surveys and opinion polls; and so forth.

7. Teach toward the objectives, not the objectives themselves The objectives in this document provide targets for student achievement by the end of each year, not individual lesson plans. Feel free to mix and match the objectives and bring students to them by circuitous routes.

8. Don't feel limited by these objectives This document is a core, not an all-inclusive or exclusive guide to science education. Teachers should feel free to go beyond it whenever students' interests - or their own - pull in that direction.

9. And of course, use hands-on activities Maximize the amount of "stuff" that children can get their hands on in your classroom, even if it is simple everyday material like seashells, plants, or magnifying glasses.

PHILOSOPHY AND GOALS

The goal of science instruction implicit in this document is the maximum development of scientific literacy in our students. Accordingly, science classes from kindergarten through eighth grade should help students in:

1. Acquiring a basic knowledge of the natural and technological world - having a feeling of "at-homeness" in their world.

2. Understanding basic science concepts, principles, and nomenclature that can apply to new situations (both in school and in the outside world).

3. Knowing enough about science so they can follow scientific and technological developments in the news for the rest of their lives.

4. Grasping the underlying structure, orderliness, and finely-tuned interrelations of the natural and physical world.

5. Seeing science as an open-ended activity, in which what is known and believed is subject to change at any time.

6. Developing the habit of asking questions about everything, of being full-time skeptics.

7. Developing flexibility, originality, and ingenuity; approaching new problems in a fresh and original way.

8. Developing a scientific style of dealing with issues and problems, including: honesty, open-mindedness, a careful examination of premises, a respect for logic, a demand for verification and replicability, and an openness to novel ideas.

9. Learning to discriminate between:
   -description and analysis
   -observation and inference
   -hypothesis and theory
   -fact and opinion
   -cause-and-effect explanations and those based on superstition and closed to investigation
   -reliable and unreliable sources

10. Having direct, hands-on experience with science experiments and investigations to find answers to questions.

11. Learning a great deal about a few scientific topics of personal interest; getting a real sense of mastery of a few areas of science.

12. Being able to plan and work alone and cooperatively with others in science investigations.

13. Becoming skilled and careful observers, and recording observations accurately.

14. Acquiring the ability to recognize patterns - sorting and classifying data intelligently.

15. Developing skill in the crucial science processes of hypothesizing and predicting.

16. Developing skill at analyzing data, testing hypotheses, and drawing conclusions

17. Understanding and being able to use basic science equipment.

18. Being able to make accurate measurements in the English and metric systems.

19. Being able to find information in reference books, other sources, and the outside world.

20. Being familiar with the history and current work of science, and areas in which scientists do not yet have answers.

21. Relating science and technology to people who made breakthrough discoveries; getting a sense of how scientists work, and the inquisitiveness, genius, energy, persistence, and luck that drives science.

22. Being aware of the ways in which the development of scientific knowledge is constrained by the belief systems and prejudices of each era.

23. Understanding the scientific and ethical aspects of some current social problems and their possible solutions - e.g. in medicine, energy, population, weapons systems, environmental quality, conservation of natural resources, etc.

24. Relating science studied in school to vocations and avocations, and examining science-related occupations.

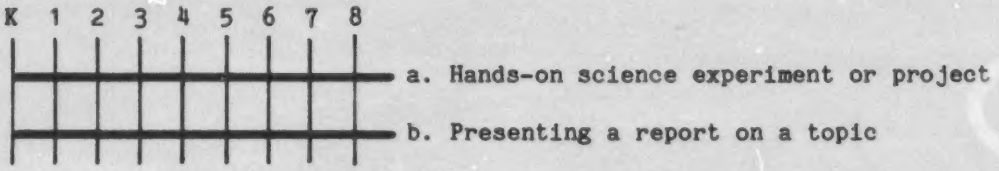
25. Developing confidence in their ability to discover things for themselves and search for explanations, not just in school but for the rest of their lives.

26. Preserving the "childish" willingness to ask questions, make up theories, speculate in uncharted fields, work with imperfect knowledge, and search for clues; maintaining a sense of wonder about the world.

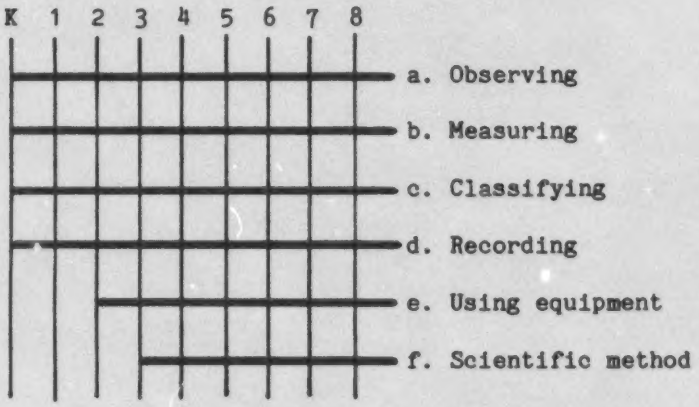
CONTENT STRANDS

Below are the strands that run through the different levels of this document. The horizontal lines show where each major strand begins and ends.

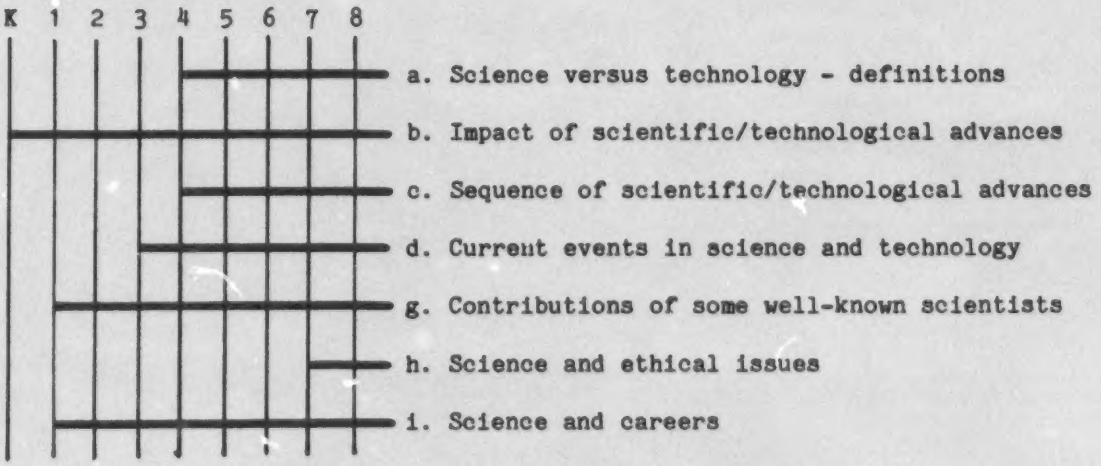
A. SCIENCE EXPERIENCES



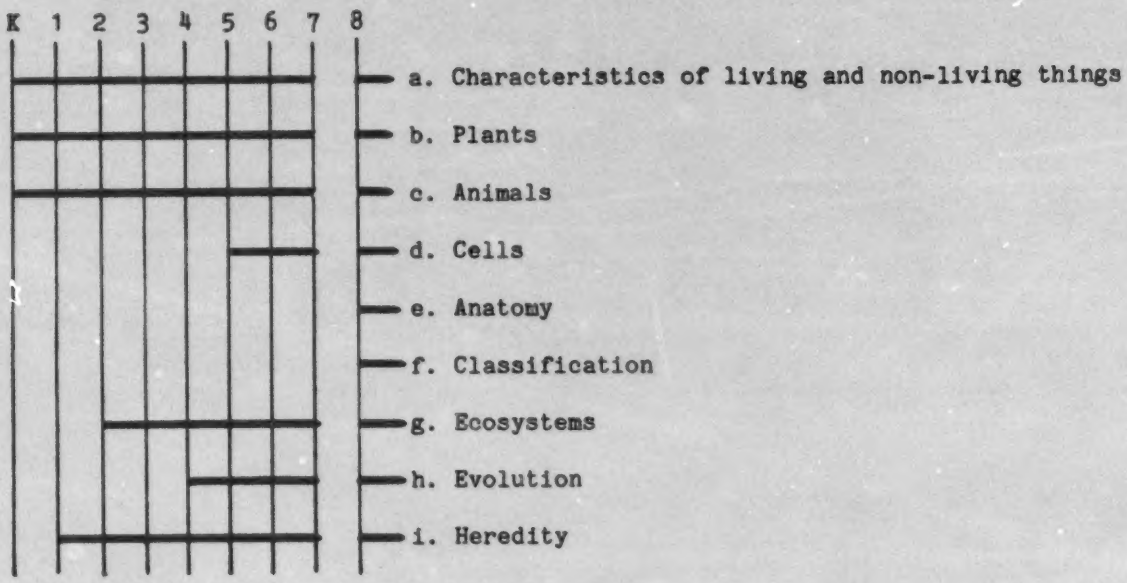
B. SCIENCE SKILLS AND PROCESSES



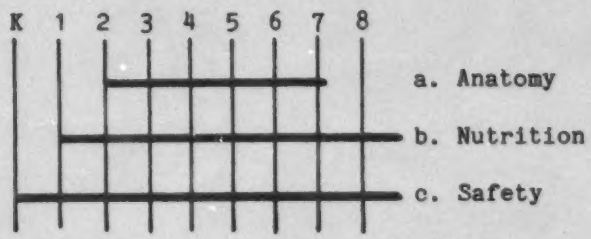
C. SCIENCE AND SOCIETY


K 1 2 3 4 5 6 7 8
a. Science versus technology - definitions
b. Impact of scientific/technological advances
c. Sequence of scientific/technological advances
d. Current events in science and technology
g. Contributions of some well-known scientists
h. Science and ethical issues
i. Science and careers

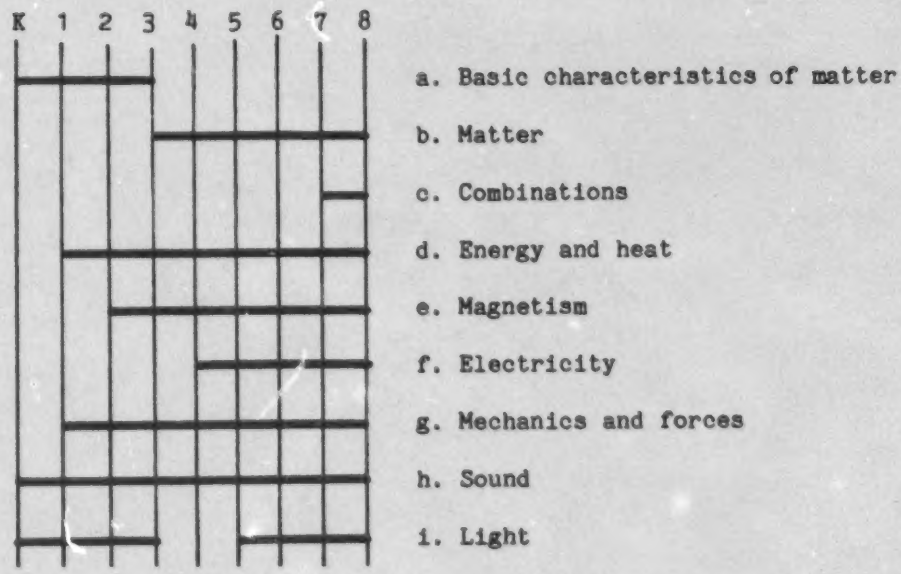
D. LIFE SCIENCE



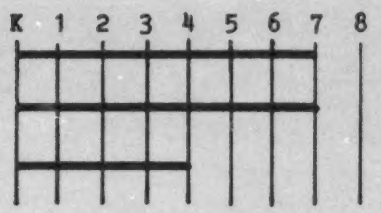
E. HUMAN BIOLOGY AND HEALTH



F. PHYSICAL SCIENCE



G. EARTH SCIENCE

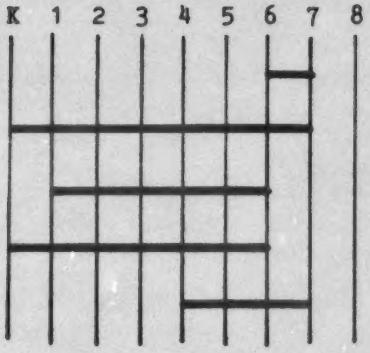


a. Weather

b. Geology

c. Prehistoric life

H. ASTRONOMY



a. Origins of the universe

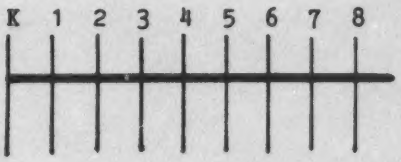
b. Solar system and beyond

c. The moon

d. Space travel

e. The seasons

I. SCIENCE READING



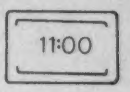
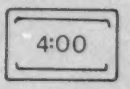
a. Reading from the list of children's science books and magazines

KINDERGARTEN

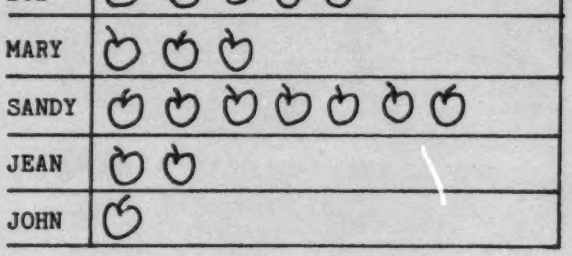
A. SCIENCE EXPERIENCES

(1.) Working with hands-on science materials, individually or in a small group. The topic of the experience should be chosen by each student, drawing on the content for this grade level (see sections C - H) or other topics of interest to the student. The experience is open-ended in terms of content, but should incorporate as many of the following general science processes as possible: a. Stating what you want to find out b. Deciding what materials you need c. Gathering the materials you need d. Working with the materials e. Observing and describing what happened f. Presenting the conclusions in a show-and-tell	1. Teacher observation: By the end of the year, has the student completed and reported on at least one direct science experience which includes some of the important science processes? Some possible experiences: -observing solitary animals or groups of animals -watching a plant grow from seed to maturity -taking care of an animal and watching it grow up -watching weather changes over a number of days, especially before, during, and after a storm -cooking oatmeal cookies or some favorite recipe -making a toy that teaches a science lesson
(2.) Using books (see section I), field trips, or other experiences to find out a lot about at least one topic, and presenting a show-and-tell on that topic to classmates	2. Teacher observation: Has the student learned a lot about one topic and presented a brief oral report to classmates? -spiders' webs; how spiders catch their prey -an ant colony, the comings and goings of the inhabitants -observing the habits and antics of one breed of dog -a story about some wild animal of your choice (a squirrel, whale, woodchuck, bird, snake, etc.)

KINDERGARTEN B

B. SCIENCE SKILLS AND PROCESSES	
(1.) Observing carefully; noticing such details as size, shape, color, texture, taste, smell, position, and relative weight and time taken, using a hand lens where necessary	1. Teacher observation: Have students examine an array of objects, including sticks, leaves, buttons, coins, pebbles, a mixture of seeds or grains, shells, marbles, feathers, etc. Children should attempt to characterize each object in detail (with or without a hand lens).
(2.) Measuring time to the whole hour [Math correlation]	2. Match the time given on the dial of the clock with the correct time given on the face of the digital clock by drawing a line from one clock to the other.  
(3.) Making rough estimates of which of two objects is lighter and which is heavier.	3. Teacher observation: Have students place the objects used in B-1 in a row according to their weight by handling each object in turn and comparing it with others until the lightest is at one end and the heaviest is at the other end.
(4.) Telling that a thermometer with a higher reading shows that something is hotter, and a thermometer with a lower reading shows it is cooler [Math correlation]	4. Circle the picture of a glass of water having the highest temperature.

KINDERGARTEN B, C

(5.) Organizing and classifying objects in categories or sequence (e.g., rocks by texture, leaves by shape, etc.)	5. Teacher observation: Have students arrange all the objects used in B-1 in a row from: a. the smoothest to the roughest b. the smallest to the largest c. the longest to the shortest d. the fastest-falling (if dropped) to the slowest-falling e. in order of color closest to red, orange, yellow, gree, blue, violet f. in order of color closest to red orange, yellow, green, blue, violet
6. Getting information from simple picture graphs [Math correlation]	6. This graph shows how many apples these children ate in a week. Who ate the most apples? Who ate only two apples? 
C. SCIENCE AND SOCIETY	
(1.) Naming several ways in which science has affected our lives and changed the world (e.g., electric lights; automobiles; airplanes; cures for diseases; etc.)	1. What has science given us that: a. lets us work and play after dark? b. allows us to travel and visit friends a mile away in a few minutes? c. allow us to visit relatives many miles away in a few hours d. allows us to travel to far-off countries overnight? e. keeps people well most of their lives?

KINDERGARTEN D

D. LIFE SCIENCE	
(1.) Distinguishing between living and non-living things	1. a. Point out all the objects in a picture book that are living. Why do you say they are living? b. Point out all the living things in the classroom. c. Point out some living things on the playground. d. Point out some non-living things. e. Point out non-living things that were made from things that were once alive.
(2.) Classifying a group of living things as plants or animals	2. a. Point out all objects that are plants in the classroom and on the playground b. Point out some objects that are animals [Be sure students know that animals are not just mammals, but include the entire animal kingdom.]
Plants (3.) Observing a variety of plants in the area around school and home and in books, and grouping plants according to size, shape, feel, appearance, etc.	3. Teacher observation: Give students a chance to examine, touch, and learn some general representatives of plant groups, including: woody trees and shrubs, soft-bodied herbaceous non-woody plants; and true flowering plants and non-flowering plants. The best source of samples would be a park or arboretum.
4. Identifying some common spring flowers	4. Teacher observation: On a walk in the garden, park, woods, or aboretum, children should be able to identify some domestic flowers (e.g., tulips, daffodils, crocuses, azalea, rhododendron, irises), and some wildflowers (e.g., milkweed, dandelions, thistles, buttercups, daisies, black-eyed Susans, Queen Anne's lace). An enrichment question: What happens to spring flowers later in the summer? By winter next year?

KINDERGARTEN D

(5.) Recognizing the different parts of a tree: branches, leaves, trunk, bark, and roots	5. Teacher observation: Students should be able to identify the simple, major parts of a tree and tell how they serve the living tree during its lifetime: bark, branches, leaves, roots.
(6.) Identifying the things plants need to live and grow	6. Teacher observation: Students should know that plants will not grow and may die if they do not get energy (light and heat) and nutrients (foods) from the soil and gases from the air. It is useful to compare plants' needs with our own needs.
Animals (7.) Classifying animals according to important physical differences	7. Teacher observation: Students should be able to separate animals into categories like these: a. <u>number of legs</u> (two, four, six, eight, and many-legged), giving examples of each b. <u>size</u>, from the very large (elephants) to the very small (microscopic animals such as flatworms and water fleas) c. <u>covering</u> (naked skin, plates of hide, scales, feathers, hair, horny covering, etc.)
(8.) Identifying the homes in which some common animals live - nests, hives, holes in trees, caves, roofs of houses, city parks, etc.	8. Teacher observation: From readings and field trips, students should be able to simulate animal abodes with simple materials. The models might include: beaver homes, bird nests, woodchuck burrows, bats' caves, mouse nests, etc.
(9.) Identifying some of the things that animals need to survive (food, air, water, etc.)	9. Make a list of all the things you can think of that animals need to stay alive. How many can you think of?
(10.) Describing the most important things to know when taking care of pets at home or at school	10. From your own experience taking care of a pet (or from talking to someone who has a pet), what are the most important things in keeping a pet healthy and happy?

KINDERGARTEN D, E

(11.) Describing some of the similarities and differences between baby animals and their parents	11. In what ways are puppies like grown-up dogs? In what ways are kittens like grown-up cats? In what ways are calves like grown-up cows?
(12.) Describing and giving reasons for the behavior of one common animal (e.g., dog, cat, squirrel, etc.)	12. Why do dogs circle around and around before lying down? [primitive grass bedding-down instinct] Why do dogs pant? [perspiring] Why does a dog bark and under what conditions? [anger, fear, warning] Why do dogs like to travel in packs? [from a dog-pack instinct thousands of years old] Similar questions can be asked about other domestic animals.
13. Identifying some common insects, birds, mammals in the Boston area - ant, bee, etc.; bluejay, robin, etc.	13. Teacher observation: Students should know some of the common animals in the Boston urban and suburban areas: red fox, swans, white footed mice, Norwegian rats, squirrels, chipmunks, ducks, robins, English sparrows, bluejays, pigeons, cats, dogs, eastern grass snakes, box turtles, ants, bees, mosquitoes, butterflies, beetles, etc.
E. HUMAN BIOLOGY AND HEALTH	
(1.) Naming some things you can sense with each of the five senses: sight, hearing, touch, smell, and taste	1. What is something you can only hear? What is something you can only see? What is something you can only smell? Now think of something that you can touch, taste, smell, hear, and see [a potato chip]
(2.) Describing some ways in which you are similar to and different from your parents	2. Teacher observation: Can students go through the following checklist comparing themselves with their parents for similarities and differences? a. body build b. height c. weight d. hair color e. eye color f. kind of nose g. kind of chin h. foot size, shape i. strength j. number of fingers k. knowledge l. skills m. temperament n. others?

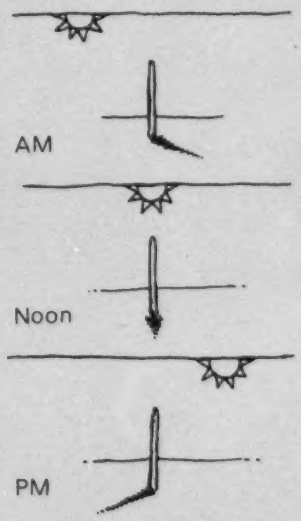
KINDERGARTEN E

(3.) Naming the basic things you need to live and grow: food, air, water, sleep, shelter, etc.	3. What are the things you <u>must</u> have to stay alive? Are they the same for all people? How do they compare with what animals need? With what plants need?
(4.) Identifying the different parts of one's body (e.g., arms, legs, ears, teeth, etc.) and naming some functions of each part	4. Teacher observation: Students should be able to identify these body parts: head, nose, chin, ears, jaw, mouth, tongue, teeth, legs, arms, feet, joints, fingers, toes; they should be able to tell the function of each.
Health and Safety (5.) Grouping a list of substances according to those that are edible (common foods); those that cause sickness (spoiled foods, other inedibles); and those that are poisonous (certain medicines, mushrooms, asbestos, etc.)	5. Teacher observation: Have students sort the objects below (or others like them) into three categories: a. things that are safe to eat b. things that can make us sick c. things that are poisonous -fresh milk -spoiled milk -oranges -rotten eggs -oven cleaner -pizza -plant fertilizer -mushrooms -hamburgers -rat poison -peanuts -others
(6.) Identifying some major safety hazards of this age group, and describing ways of minimizing the risks of each one: -pedestrian accidents -injuries in car accidents (safety belts) -fires in buildings (prevention and escape) -open flames and matches -hazardous products, poisons -sharp objects, kitchen utensils	6. Teacher observation: Can students name the most hazardous activities they engage in, and list some ways of making each less dangerous?
7. Identifying the reason that people wash their hands before handling food	7. What is usually present on your hands (it's too small to see)? How does washing help control this?

KINDERGARTEN F

F. PHYSICAL SCIENCE	
(1.) Grouping a list of substances according to whether they are solid or liquid, light or heavy, small or large, dark or light-colored, etc.	1. Teacher observation: Have students group real objects or pictures of objects into categories (see B-1 for a list): a. solid or liquid b. light or heavy c. little or big d. dark or light-colored
(2.) Observing the characteristics of water by experimenting with pouring, with things that float and sink, with pumps, syringes, and streams, etc.	2. Teacher observation: Students should become aware of the difference between objects that float and sink in water. In time they should be able to make predictions about objects before immersing them in water. Experimenting with a pump or syringe, students should be getting acquainted with the principle of suction and pressure.
(3.) Grouping objects by some important characteristics: -whether they sink or float in water -whether magnets will stick to them -whether they are soft or hard -etc.	3. Teacher observation: Students should be able to experiment with and understand the differences between: -objects that sink or float in water -objects that stick to magnets -etc.
4. Observing the action of different equal-arm balances (such as see-saws, pan balances, etc.)	4. Teacher observation: Playing on a see-saw is the best way to grasp this principle at an intuitive level. Students should be able to extend what they know to smaller equal-arm balances in the classroom - a pencil, a ruler, a home-made pan balance, etc.
Sound (5.) Observing differences in sounds: -louder or softer -near or far -high-pitched or low-pitched	5. Teacher observation: Can students guess how far away different sounds are as they listen with their eyes closed? Can students tell whether a note is high or low on the piano keyboard, or is a high or low string on a guitar? Can students name sounds as loud or soft?

KINDERGARTEN F, G

(6.) Identifying some sounds that give warnings (e.g., a truck's horn or back-up beep, a train's whistle, a police officer's whistle, a dog's growl, a snake's hiss, etc.)	6. How does a police officer warn people to stop if they are not watching? How does a fire engine driver warn people to clear the road? How does a train engineer tell motorists to beware? How do some animals let other animals know they are afraid or angry? Give some examples.
Light (7.) Recognizing and naming the primary colors (red, blue, and yellow) and the secondary colors (green, orange, and purple)	7. Teacher observation: Students should be able to identify all primary and secondary colors. Some may be able to mix secondary colors, and differentiate hues grading between the colors.
8. Recognizing that shadows are longer when the sun is lower (morning or afternoon) and shorter when the sun is overhead (closer to noon)	8. Teacher observation: Students should be able to recognize how shadows cast by the sun change over the course of the day. An enrichment understanding would be for children to grasp the principle of sundials. 
G. EARTH SCIENCE **Weather** (1.) Describing some of the differences between the four seasons in Boston	1. What kind of weather do we usually have in January and February? What kind of weather do we usually have in July and August? What are the main differences? When does most of the rainfall come in New England? When do we have the clearest skies? What kind of storms usually come in the summer? What kind of storms do we often get in the winter?

KINDERGARTEN G, H

(2.) Describing different weather conditions that we see in Boston - sunny, muggy, cloudy, drizzly, rainy, snowy, etc.	2. Describe a rainy day; an overcast day; a sunny day; a hot and humid day; a thunderstorm; a day when it is snowing; a blizzard. Describe the kind of weather you like best.
(3.) Recognizing that wind is moving air, and describing ways you can tell that the wind is blowing	3. If you are standing outside, how can you tell which way the wind is blowing? Can you think of two ways that you could point into the wind?
Geology 4. Sorting a variety of rocks by size, color, shape, and texture	4. Teacher observation: Students should be able to sort a collection of different kinds of rocks according to these and other criteria: -smoothest to roughest -heaviest to lightest -dark-colored to light-colored -largest to smallest -banded to plain -hardest to most crumbly
H. ASTRONOMY 1. Recognizing that the higher you get off the ground, the more you can see	1. From which of these places can you see the most of Boston? From which can you see the least of Boston? -standing on the street outside the school -from the classroom window -from your window at home -from the top of the Prudential Center -from an airplane flying over Boston
2. Recognizing that if you rose high enough in the air, you could see the planet Earth as a huge ball with blue water, green and brown land, and white clouds	2. If you got into a rocket and went straight up a thousand miles and then looked down at the Earth, what would the Earth look like? How do you know?
(3.) Recognizing that the sun gives us light and heat	3. When is it usually hotter, nighttime or daytime? Why?

KINDERGARTEN H, I

4. Exploring the basics of space travel - rockets, astronauts, the space shuttle, etc.	4. Teacher observation: Do students know about the space shuttle, rockets, astronauts, etc.? Can they draw pictures, and point out pictures in books?
I. SCIENCE READING	
(1.) Listening to readings from at least three of the science books or magazines listed at the end of the first grade objectives, either as part of the individual project (objective A-2) or as a separate activity	1. Teacher observation and record-keeping

FIRST GRADE

A. SCIENCE EXPERIENCES

(1.) Carrying out and reporting on at least one hands-on science project, working individually or in a small group. The topic of the experience should be chosen by each student, drawing on the content for this grade level (see sections C-H) or other topics of interest to the student. The experience is open-ended in terms of content, but should incorporate as many of the following general science processes as possible: a. Stating what you want to find out b. Deciding what materials you need c. Gathering the materials you need d. Carrying out the experiment e. Observing and describing what happened f. Making a record of what happened g. Sorting, comparing, and classifying the information from the experience h. Presenting the observations in oral, written, or graphic form	1. Teacher observation: By the end of the year, has the student completed and reported on at least one direct science experience which includes most of the important science processes? Some possible experiences: - observing animals or plants, whether at school or at home - taking care of an animal or plant, whether at school or at home - collecting basic data on the weather or seasonal changes over a number of days or weeks - carrying out a simple experiment with plants - e.g., exposing one plant to light and keeping another in the dark - keeping track of children's growth over a period of months
(2.) Using books (see section I), interviewing, field trips, or other experiences to find out a great deal about at least one topic, and presenting a report on that topic to classmates	2. Teacher observation: Has the student chosen a topic, made a thorough investigation of it, and presented an oral report to classmates? Some possible topics: - storms: kinds, uses, dangers - mammals: as a group, origins, common ones in New England, why a successful group - chemicals: useful and harmful - aircraft: history, development - spacecraft: rockets, development, potential - foods: sources, world diets - dinosaurs - creatures of the sea - computers: origins, current uses - radio and television: invention - power generating plants - ships, past and present - forests and trees, their growth and protection - meadows, grasslands, and prairies - mountains of the world - rivers of the world - oceans of the world

FIRST GRADE B

B. SCIENCE SKILLS AND PROCESSES

Observing

(1.) Observing carefully; noticing such details as size, shape, color, texture, weight, taste, smell, position, time taken, etc. (possibly using a hand lens)

1. Teacher observation: Students should show an improved proficiency in making accurate, penetrating observations using all their senses. They should be able to examine everything around them, at home and in school, becoming critical observers. They should begin to use hand lenses, binoculars, etc. to extend their senses, and be able to make rough drawings and notes of what they see.

Measuring

(2.) Choosing the right measuring instrument for a task (e.g., a ruler, thermometer, cup measure, etc.) [Correlation with Math objectives]

2. What measuring instrument would you use if you wanted to:
-measure how tall you are?
-tell how much you weigh?
-measure flour for a recipe?
-tell how hot it is outside?

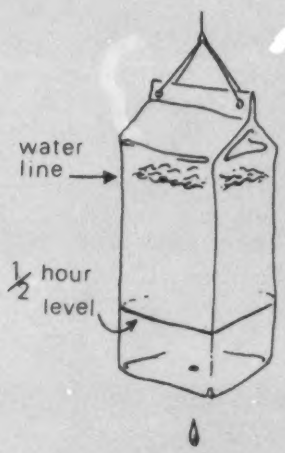
(3.) Measuring the length of an object to the nearest inch [Correlation with Math objectives]

3. What is the length of your desk? What is the length of your classroom? Use a ruler to find out.

(4.) Comparing the weight of two objects to see which is heavier [Correlation with Math objectives]

4. Choose two books. Which one is heavier? How can you tell?

(5.) Measuring time taken to the nearest hour or half hour [Correlation with Math objectives]



5. Time an event to the nearest half hour using a real clock or a water clock. [Enrichment: To make a water clock, punch a small hole in the bottom of a milk carton, fill the carton with water, and use the classroom clock to time how long it takes the carton to empty. You can mark the level of the water every half-hour.]

FIRST GRADE B, C

(6.) Comparing thermometer readings to see which is hotter and which is cooler [Correlation with Math objectives]	6. Find the coolest and the warmest place in your classroom by using a thermometer to measure the temperature in each place.
Classifying (7.) Organizing and classifying objects by categories or in sequence	7. Get a good many objects of various kinds (pebbles, stones, acorns, buttons, pencils, stamps, coins, paper clips, books, seeds, leaves, etc.) and sort them in the following ways: a. largest to smallest b. heaviest to lightest c. tallest to shortest d. finest to coarsest e. brightest to dullest f. hardest to softest g. prettiest to ugliest (your opinion)
Recording 8. Recording information in the form of rough sketches, and getting information from sketches and graphs done by others [Correlation with Math objectives]	8. Teacher observation: Can students make rough picture graphs of information they have collected (as in the previous objective)?
C. SCIENCE AND SOCIETY (1.) Identifying some applications of science in the world around us (e.g., electricity, cars, trains, jets, indoor plumbing, space travel, computers, calculators, medical cures, etc.)	1. Tell how some inventions and discoveries have changed our way of life: a. ways of travelling on the ground b. ways of travelling in the air c. ways of travelling in the water d. ways of communicating with people far away e. household conveniences (vacuum cleaners, dishwashers, etc.) f. calculating machines g. ways of fighting diseases h. lighting our homes
2. Identifying the major work of at least one important scientific inventor, past or present	2. Give examples of inventions or discoveries by a few of these scientists: Fulton, Einstein, DeForest, Bell, Edison, Kepler, Archimedes, da Vinci, Copernicus, Curie, Pasteur, Elijah McCoy, Franklin, Carver, Mendel, Darwin, Wright brothers, Marconi

FIRST GRADE C, D

3. Identifying some science-related jobs (doctors, nurses, engineers, pilots, astronauts, chemists, physicists, etc.)	3. What are three grown-up jobs for which knowing a lot about science is important?
D. LIFE SCIENCE	
(1.) Distinguishing between living and non-living things, based on observation, and listing some distinctions between them	1. How can you tell whether something is living or non-living? Make a list of the differences between some living and non-living things.
Plants (2.) Distinguishing between different kinds of plants around home and school; naming their main characteristics	2. Examine plants in the classroom, around the school, in local parks, and at home. Can you classify the plants in the following ways? a. flowering plants (lily) b. non-flowering plants (pine) c. woody plants (trees) d. soft-bodied plans (mosses) e. climbing plants (poison ivy) f. creeping plants (princess pine) g. primitive plants (horsetails) h. microscopic plants (algae)
(3.) Naming the basic parts of plants (stem, leaves, roots, flowers), and some of their functions	3. Teacher observation: With a real plant or a drawing of a plant, can the student point out the stem, leaves, roots, and flowers and tell what each one does to keep the plant alive.
(4.) Describing some conditions that plants need to survive (light and water)	4. What does a plant need to stay alive? Where does it get what it needs to live?
(5.) Recognizing that most plants grow toward light	5. When a plant is placed in a window, in which direction does it grow?
(6.) Describing the observable changes in a plant as it grows from a seed to a mature organism	6. Teacher observation: Students should keep records of the growth of a plant from a seed in the classroom, at home, or outside over a period of weeks. Their records could include drawings, measurements, notes, etc.

FIRST GRADE D

Plants and Animals (7.) Naming some important distinctions between plants and animals	7. What are the main differences between plants and animals? Do plants make their own food from raw materials? Do animals? Can plants kill animals? [Venus's-flytrap] What is the food cycle which includes both plant and animal? Do plants move? How far can they move? Do plants travel? Do plants have blood? Do plants have a heart? Do plants live longer than animals?
(8.) Distinguishing between the way some plants and animals get food - plants, from sunlight, water, etc.; animals, by eating plants and other kinds of food	8. What do plants use for food? What kinds of foods to some animals eat? Are there animals that eat only vegetable matter? Only meat? Can you describe natures's food web that connects plants and animals?
Animals (9.) Studying a group of animals and classifying them according to certain criteria: -movement: flying, walking, hopping, crawling -size -behavior: hunting, grazing, etc. -others	9. Teacher observation: Using good pictures of animals, or a visit to a zoo, children should be able to place many animals in one or more of the following categories: a. hunted (prey) or hunters (predators) b. very large, moderately large, small, or microscopic
(10.) Describing different body coverings of some common animals (fur, feathers, scales, etc.) and telling how the coverings help each kind of animal survive	10. Teacher observation: Using good pictures of animals, or a visit to a zoo, children should be able to place many animals in one or more of these categories: a. flying, jumping, swimming, hopping slithering, swift-running, slow lumbering, climbing, sailing, diving b. naked skin, scales, feathers, horny caripace, horny plates, calloused skin, fur, hair

FIRST GRADE D

(11.) Grouping familiar animals according to whether they hatch from eggs (frogs, birds, butterflies, lizards) or whether they are born alive (dogs, whales, cows, etc.)	11. Teacher observation: Students should have a rudimentary idea of how different animals are born. Using pictures, children should be able to put animals into two categories: those born alive, and those born directly from eggs. [Note that all animals begin as eggs, but not all are born in eggs; this is a distinction which might be introduced as an enrichment topic.]
(12.) Naming some of the different places in which animals live - nests, forests, city parks, plains, caves, under houses, etc.	12. What animals are found in the following: trees and shrubs; banks; caves; edge of water, rivers, lakes, and the ocean; abandoned houses or barns; dump heaps; under buildings; stumps; grassy meadows; forests; swamps; marshes; dead trees; muddy bottoms of swamps and rivers; hollows of blown-down trees?
(13.) Describing the behavior of a familiar local animal (squirrel, frog, cat, insect, etc.)	13. Choose one kind of animal and tell how it: a. acts when it is scared b. acts when it is angry c. catches or gets food d. shows affection e. acts when it is curious f. protects its young

FIRST GRADE D

(14.) Naming some common sounds that animals make (barking, chirping, roaring, hissing, etc.) and suggesting purposes each noise might serve	14. What sounds are made by some of these animals: dogs, cats, snakes, lions, squirrels, robins, crows, whipoorwill, cow, horse, owl, hawk. Here are some reasons animals make noises: -alerting other animals -alarmed -busy noises -scolding -courting -calling a mate -showing anger -chasing off intruders -playing hurt to protect its young
(15.) Naming some ways that people use animals (as pets, as food, for entertainment, for work, etc.)	15. What animals do people use for each of these? -hauling vehicles -guarding property -providing milk -providing hides for coats, shoes -thrashing grain -pumping water -providing meat -providing eggs -entertaining people -keeping people company
16. Describing what a particular wild animal eats, and the other things it needs to survive and grow	16. What does one of the following wild animals eat as its normal diet: wolf, mountain goat, squirrel, bluejay, woodpecker, heron, lizard, snake, turtle, lion, whale
Heredity 17. Recognizing that living things reproduce, and that each new generation is similar to the last (like begets like)	17. Teacher observation: Children should have a general idea of the process by which species reproduce themselves, and should be able to match pictures of baby animals with pictures of grown-up animals of the same species.

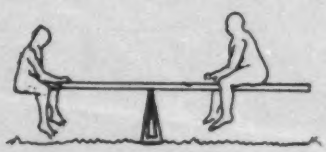
FIRST GRADE E

E. HUMAN BIOLOGY AND HEALTH (1.) Identifying which of our five senses is being used to learn about one particular thing in the world around us (e.g., a car honking, the moon shining, milk that has gone sour, a wet towel, bacon cooking)	1. Which of your five senses do you use when you: -enjoy a good meal -are pushed on a swing -look for a gas pipe leak -test soil for planting flowers -look for a puncture in an inner tube [more than one!] -tell whether milk has gone sour -avoid being hit by cars
(2.) Describing some important ways in which a baby is different from a toddler; a toddler from a six-year-old	2. What are the main differences between a baby and a toddler (a one- or two-year-old)? Between a toddler and a six-year-old?
3. Identifying at least two things we might inherit from our parents and grandparents (e.g., hair color, eye color, height, build, complexion, etc.)	3. Can you find out from whom in your family you got your: -eye color -hair color -nose shape -face shape -body build -bone structure -complexion -likes and dislikes -your temperament
(4.) Identifying the things that each of us needs to survive and grow (air, water, food, sleep, exercise, care, etc.)	4. If you were stranded on a deserted island in the middle of the Pacific Ocean, what things would you look for to survive? What would you build? What things would you consider eating?
Nutrition (5.) Recognizing that people eat a great variety of foods, and that variety is important to a healthy body	5. Would it be healthy for a person to eat only French fries and catsup day in and day out? Why? What are some of the things that people need to have in their diet?

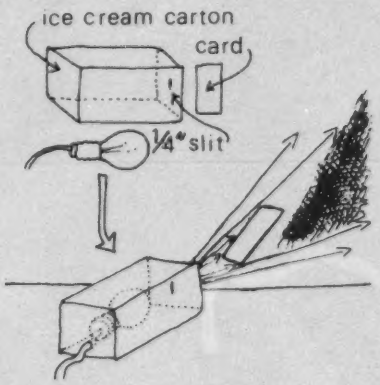
FIRST GRADE E, F

(6.) Identifying foods which are less helpful to growth ("junk foods" - e.g., candy, cookies, packaged chips, soft drinks)	6. Which of these are considered "junk food" (food that doesn't help you grow and stay healthy): milk, eggs, French fries, steak, bread, yogurt, pizza, soft drinks, peanuts, apples, cereal, cookies, ice cream, pancakes, lettuce, spinach, potato chips, broccoli, candy.
Safety 7. Identifying the reasons that people wash their hands before handling food	7. Why do people think it is so important to wash their hands before they eat? What sort of things might get on your unwashed hands that could make you ill? What good is soap? Why do surgeons wash their hands so carefully before they operate?
(8.) Identifying some major safety hazards for children this age, and describing ways to minimize the risks of each one: -pedestrian accidents -injury in car accidents (safety belts) -open flames, sharp tools, utensils -fires in buildings (prevention and escape) -poisons and corrosives -discarded refrigerators with attached doors, etc.	8. What are ways that children your age can be seriously hurt or killed? Make as long a list as you can. Then go over it and think of ways that each dangerous situation can be avoided.
9. Identifying some dangerous toxic substances found in parts of our environment (e.g., lead paint, mercury, certain household cleaners, asbestos, spoiled food, etc.)	9. Make a list of the most dangerous poisons and other harmful substances that can be found at home, in the neighborhood, around the city, or at school.
F. PHYSICAL SCIENCE	
(1.) Grouping things according to important physical characteristics (solid or liquid, texture, hardness, smell, density, etc.)	1. Teacher observation: Can the student put a wide array of things (or pictures of things) into groups according to: a. solid or liquid b. smoothest to roughest c. hardest to softest d. sweetest-smelling to vilest-smelling e. heaviest to lightest f. etc.

FIRST GRADE F

(2.) Describing what happens to water when it is boiled or left out in the sun	2. When you boil a pot of water for a long time, what happens to the water? If you leave a bowl of water out in the sun for several hours, what happens to it? Why does the water disappear? Where does it go?
(3.) Grouping things according to whether they sink or float in water	3. Teacher observation: Can the student distinguish between objects that sink and float in water (after testing them in water, then making predictions before testing them)? An enrichment activity is to see if it is possible to modify the shape of some things that sink so they will float (e.g., by making a piece of clay into a boat).
(4.) Listing some common sources of light and heat energy (the sun, fire, electric bulbs, etc.)	4. What are some things that give us heat? What are some things that give us light? Name as many as you can think of.
(5.) Predicting whether a magnet might or might not pick up a series of objects	5. Teacher observation: Can the student predict (after some experimentation) the kinds of objects that attract a magnet and those that do not?
(6.) Recognizing that two equal weights can balance each other on a see-saw	6. Leroy gets on one side of a see-saw and Sharnitha gets on the other side. They both sit on the very end. Leroy weighs more than Sharnitha. Will the see-saw balance?
7. Recognizing that a light person can balance a heavier person on a see-saw if the lighter person sits further out from the center (fulcrum)	7. If Leroy moves closer to the middle, could the see-saw balance? 

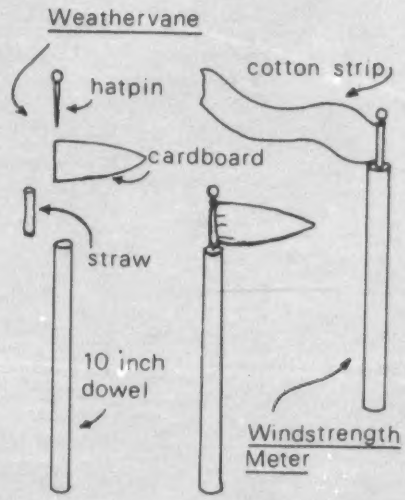
FIRST GRADE F

(8.) Predicting what will happen to various objects when they are dropped on the floor (will they bounce, break, flatten, spread out, or pile up?)	8. Can you predict what will happen to each of these when they are dropped on a hard floor from a height of three feet? a china dish; a rubber ball; a wooden block; a feather; a styrofoam block; a golf ball; chalk; clay; a glass of water; a plastic cup of water; a half-dollar
Sound 9. Describing a sound as being longer or shorter, louder or softer, higher- or lower-pitched, or more or less like another sound	9. Teacher observation: Can the student name a variety of sounds made by a piano, guitar, other students, birds, recordings, etc. in terms of: -loud or soft -near or far -high-pitched or low-pitched -familiar or unfamiliar -pleasant or unpleasant
Light 10. Recognizing that when you look at a page of a book in a mirror, all the letters are backwards	10. Why is it more difficult to read your name when you look at it through a mirror?
11. Predicting where a shadow will fall, given an object and a source of light	11. Can you predict what kind of shadow will be cast by a card when it is tilted different ways? You might experiment with this kind of light box, then try to make predictions. 
(12.) Distinguishing between primary and secondary colors (red, yellow, and blue; orange, green, and purple) [maintained]	12. What are the three primary colors? What are the three secondary colors?

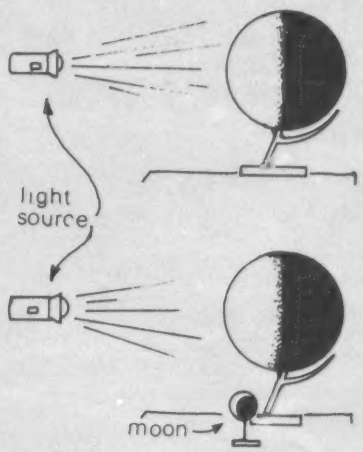
FIRST GRADE G

G. EARTH SCIENCE **Weather** (1.) Describing the characteristics of each of the four seasons in Boston	1. From your own experience, tell what the weather is like and how things in Boston appear in each of the four seasons. Then check the list below to see if you have remembered everything: -spring, summer, fall, and winter -heavy gale winds, rain, and cold -heavy winds and warm rain -heavy winds, blinding snow, very cold -gusty winds -overcast skies -hazy blue skies -clear blue skies, clear starry nights -high long-streaked clouds and blurry sun's image -many puffy solitary clouds without rain -high altitude, thin fleecy clouds -large, towering white clouds (no rain) -large, towering grey to nearly-black clouds, heavy rain at times
(2.) Recognizing that the seasons are different in other parts of the world, and giving an example (e.g., warm winters in Florida)	2. Tell what winter is like in Florida; Fairbanks, Alaska; Cape Town, South Africa. Tell what summer is like in Sydney, Australia; Bombay, India. Tell what spring is like in Lima, Peru; in Scotland.
(3.) Describing some extreme weather conditions - blizzards, hurricanes, thunderstorms, etc. - as well as more common weather - rain, snow, sleet, drizzle, fair weather	3. What is it like being in a rainshower? A snowstorm? A hailstorm? A thunderstorm? A blizzard? A tornado? Very foggy weather? A beautiful, clear day?
4. Describing ways of telling the direction and strength of the wind	4. Think of some ways of telling which direction the wind is blowing from, and how hard it is blowing. Here are some possibilities:

FIRST GRADE G

	
(5.) Identifying ways that wind can be helpful (drying wet clothes, cooling us in summer, carrying plant seeds), and ways that it can be harmful	5. Name some ways that the wind helps make life easier for humans. Name some ways the wind can be dangerous or harmful to people.
(6.) Describe how clouds are formed from water on the ground. Be sure to use the word evaporation.	6. How does water get from the ground (in rivers, lakes, oceans, etc.) up into the clouds? Describe the process.
Geololgy 7. Recognizing that sand consists of tiny pieces of broken rock, shells, and other matter	7. What is sand made of? Where do all the tiny particles come from?
8. Recognizing that soil consists of tiny pieces of rock and decayed plants and animals	8. What is soil made of? Where do all the tiny particles come from?
9. Identifying some of the uses of stone over the years (weapons, tools, buildings, etc.)	9. Make a list of some of the ways that humans have used stone over the years.
10. Identifying some of the most common dinosaurs, and describing the world during the age when they were dominant	10. Give the names of some of the dinosaurs that used to live on Earth millions of years ago. How was the Earth different in those days from what is is now?

FIRST GRADE H

H. ASTRONOMY	
(1.) Recognizing that the Earth, moon, and sun are roughly spherical - each is shaped like a ball	1. What is the shape of the Earth, moon, and sun?
(2.) Recognizing that when it is night in Boston, the sun is shining on the other side of the Earth, and when it is daytime in Boston, it is night on the other side	2. If it is daytime here in Boston, what time of day is it in Peking, China? When it is daytime in China, what time of day is it in Boston? [Below is a way of demonstrating this idea.] 
3. Recognizing that the moon is a satellite of the Earth, and orbits our planet in an almost circular path	3. Teacher observation: Can the student describe, demonstrate, or draw the way the moon moves around the Earth?
4. Recognizing that we can see the moon in daytime and at night because the sun's rays light up its surface	4. Can we see the moon during the daytime? Where does the light of the moon come from?
5. Identifying some of the things astronauts need to survive in outer space	5. If you were making a trip into outer space as an astronaut, what are some of the things you should be sure to take along? As you make your list, think about what you are going to eat, how you are going to stay warm, what you would wear if you went outside the rocket, what you would breathe, how you would get exercise, how you would navigate, etc.

FIRST GRADE I

I. SCIENCE READING	
(1.) Reading at least three of the following science books or magazines, either as part of the individual project (objective A-2), or as a separate activity	1. Teacher observation and record-keeping

KINDERGARTEN AND FIRST GRADE SCIENCE BOOKS

Adkins	Heavy Equipment
Adler	Calculator Fun
Aliki	My Five Senses
	Corn is Maize
Allen	Everyday Wildflowers
	Everyday Turtles, Toads and Their Kin
Ames and Wyler	Prove It
Atwood	The Kingdom and the Forest
Bancroft	Animals in Winter
Barber	My Learn to Sew Book
Baylor	Before You Came This Way
	Desert Is Theirs
Berger	Energy From the Sun
Bester	Guess What
Bonners	Penguin Year
Brady	Wild Mouse
Branley	Sky Is Full of Stars
	Big Tracks, Little Tracks
	Eclipse, Darkness in Daytime
	Mickey's Magnet
	The Sun Our Nearest Star
	What Makes Day and Night?
	Snow is Falling
Brenner	Bodies
	Faces
Bronson	Coyotes

FIRST GRADE I

Bulla	What Makes a Shadow?
Burton	Life Story
Busch	Cactus in the Desert
Carrick	Crocodiles Still Wait
Caveny	Where Am I?
Cheney	Wolfie
Cobb, Vicki	Fuzz Does It!
	Lot of Rot
Cole	Fish Hatches
Cole and Wexler	Chick Hatches
Conklin	I Caught a Lizard
	Elephants of Africa
	Little Apes
	Lion Family
Cooke	Giraffes At Home
Craig	Dinosaurs and More Dinosaurs
Dabcovich	Follow the River
Davidson	Nine True Dolphin Stories
Deguine	Emperor Penguin: Bird of the Antarctic
De Paola	Cloud-Book
De Regniers	The Shadow Book
Dunn	Animals of Buttercup Farm
Duvoisin	See What I Am
Ennion and Tinbergen	Tracks
Flcathe	Fishing Around the World
Freedman	Farm Babies
Freedman	Getting Born [animals]
Freedman	Hanging On: How Animals Carry Their Young
Freschet	The Web in the Grass
Freschet	Owl and the Prairie Dog
Friedman	The Eels' Strange Journey
Froman	Mushrooms and Molds
Galdone	How Many Teeth?
	Look at Your Eyes
	Your Skin and Mine
Gans	Icebergs

FIRST GRADE I

	Birds Eat and Eat and Eat
	Hummingbirds in the Garden
	It's Nesting Time
Garelick	What Makes a Bird a Bird
	About Owls
Gemming	Born in a Barn: Farm Animals and Their Young
George	All Upon a Sidewalk
	All Upon a Stone
Gibbons	Clocks and How They Go
	Trucks
Goldin	Straight Hair, Curly Hair
	Bottom of the Sea
	Sunlit Sea
	Spider Silk
	Ducks Don't Get Wet
Goor, Ron and Nancy	Shadows: Here, There, and Everywhere
Goudey	Houses From the Sea
Greene	Truck Drivers: What Do They Do?
	Animal Doctors: What Do They Do?
Hawes	Bees and Beelines
	Lady Bug, Lady Bug Flyaway Home
	What I Like About Toads
	Why Frogs Are Wet
Heller	Chickens Aren't the Only Ones
Hirschman	In a Lick of a Flick of a Tongue
Hoban	Look Again
Hobbs	Cars
Hunington	Let's Look at Reptiles
Hurd	Starfish
	Mother Deer
	The Mother Owl
Hutchings	Things That Go Word Book
Iritani	I Know an Animal Doctor
Isenbart	A Duckling Is Born
Jaspersohn	How the Forest Grew
Johnsen, Jan	Gardening Without Soil

FIRST GRADE I

Johnson, Hannah	From Seed to Jack-O'-Lantern
Jordan	How a Seed Grows
	Seeds by Wind and Water
Kaufmann	Little Dinosaurs and Early Birds
	Bats in the Dark
Kehoe	The Puzzle of Books
Kettlekam	Shadows
Krahn	Mystery of the Giant Footprints
Kuskin	Space Story
Littledale	The Magic Plum Tree
Lubell	Birds in the Streets
Mandry	How to Grow a Jelly Glass Farm
Mari	The Apple and the Moth
	The Chicken and the Egg
McClung	Ladybug
McGovern	Little Whale
McMillan	Finest Kind O'Day: Lobstering in Maine
	Apples: How They Grow
McNulty	How to Dig a Hole to the Other Side of the World
Mendoza	Shadowplay
Miles	Wharf Rat
Miller	Lambing Time
	Big and Little
Mizamura	Emperor Penguins
	The Blue Whale
Morris	Big Cats
	Seahorse
Munari, Bruno	From Afar It Is an Island
Myrick	Ants Are Fun
O'Hagan	It's Easy to Have a Snail Visit You
	It's Easy to Have a Caterpillar Visit You
	It's Easy to Have a Worm Visit You
Parish	Dinosaur Time
Paul	Kids' Cooking Without a Stove
Penny	The Penguins Are Coming
Peterson	Birds

FIRST GRADE I

Pfloog	Wild Animals and Their Babies
Piper	Watty Piper's Trucks
Reiss	Colors
Reuter	My Mother Is Blind
Rockwell	My Doctor
	Machines
	Sally's Caterpillar
	Toad
Rublowsky	Nature in the City
Russell	Winter: A Field Trip Guide
Sarnoff	Great Aquarium Book
Schlein	What's Wrong With Being a Skunk?
Schwartz	Magnify and Find Out Why
	When Water Animals Are Babies
Sedgewick	My-Learn-To-Cook Book
Shaw	Octopus
	Alligator
Showers	Find Out By Touching
	Follow Your Nose
	Hear your Heart
	How You Talk
	Look at Your Eyes
	Use Your Brains
	What Happens to a Hamburger
	Me and My Family Tree
	No Measles, No Mumps For Me
	Sleep Is For Everyone
Shuttlesworth	ABC of Buses
Simon	Discovering Earthworms
	Mirror Magic
Sommer	Sidewalk Fossils
Spier	Gobble, Growl, Grunt
Stecher and Kendell	Max, The Music Maker
Sterling	Fall Is Here
Tinney	What Does the Tide Do?
Walter	Make a Bigger Puddle, Make a Smaller Worm

FIRST GRADE I

Ward	I am Eyes: Ni Macho
Webber	Up Above and Down Below
Zaffo	Big Book of Real Building and Wrecking Machines
	Giant Book of Things in Space

MAGAZINES

Animals (MSPCA)
Ranger Rick's Nature Magazine
Scienceland

SECOND GRADE

A. SCIENCE EXPERIENCES

(1.) Carrying out and reporting on at least one hands-on science experiment or project, working individually or in a small group. The topic of the experience should be chosen by each student, drawing on the content for this grade level (see sections C - H) or from other topics of interest to the student. The experience is open-ended in terms of content, but should incorporate as many of the following general science processes as possible:

a. Stating what you want to find out
b. Deciding what materials you need
c. Gathering the materials you need
d. Carrying out the experiment or project
e. Observing and describing what happened
f. Making a record of what happened
g. Sorting, comparing, and classifying the information from the experience
h. Presenting the conclusions in oral, written, or graphic form

1. Teacher observation: By the end of the year, has the student completed and reported on at least one direct science experience which includes most of the important science processes?

Some possible experiences:
- observing or taking care of plants or animals, whether at school or at home
- collecting data on weather or seasonal changes over a period of weeks
- carrying out an experiment on the effects of light on plants
- recording the different positions of the sun's shadows indoors or outdoors over a period of weeks
- monitoring one's own growth and the growth of other children
- making a detailed report on one aspect of a trip to the Science Museum

(2.) Using books (see section I), interviewing, field trips, or other experiences to find out a great deal about at least one topic, and presenting a report on that topic to classmates

2. Teacher observation: Has the student chosen a topic, made a thorough investigation of it, and presented an oral report to classmates?

Some possible topics:
- computer games and how they are programmed
- hot air balloons
- jet propulsion
- the sun and how it affects the Earth
- gasoline, electric, or nuclear engines
- dangerous weather and storms
- ocean creatures
- termites and their habits
- nest-building birds
- textile making, weaving, and spinning
- how foods are preserved
- glaciers and how they grow and scour
- some great mountain systems of the world
- deep mining for gold, coal, etc.

SECOND GRADE B

B. SCIENCE SKILLS AND PROCESSES

Observing

1. Observing carefully; noticing such details as size, shape, color, texture, weight, taste, smell, position, time taken, etc. (using a hand lens or magnifying glass when necessary)

1. Teacher observation: Students should be able to describe an object in some detail, pointing out its main features and comparing it to other objects

Measuring

2. Identifying the appropriate measuring instrument (e.g. ruler, scale, clock, etc.) for a particular task [Correlation with Math objectives]

2. Which of these measuring instruments would you use for each task below?
   a. ruler
   b. 50-foot tape measure
   c. measuring spoons
   d. cup
   e. graduated glass
   f. quart
   g. beam balance
   h. spring balance
   i. thermometer
   j. barometer

   ___finding the length of a football field
   ___measuring air pressure
   ___telling the temperature of a room
   ___measuring hand sizes
   ___measuring furniture
   ___measuring a heap of sand
   ___measuring a pail of water
   ___measuring the pull of a bow
   ___choosing the heaviest stone
   ___measuring flour and sugar for a cake

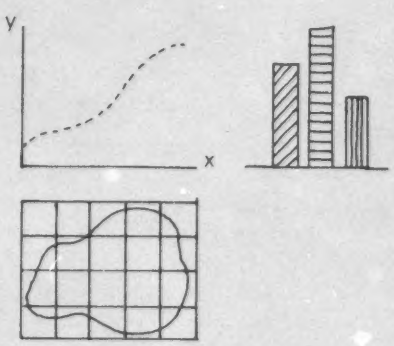
3. Measuring the length of objects to the nearest inch [Correlation with Math objectives]

3. How tall are you, measured to the nearest inch? How high can you reach standing on your toes?

4. Comparing the weights of objects using an equal-arm balance or scale

4. Teacher observation: Can students use an equal-arm balance to compare the weight of a series of everyday objects?

SECOND GRADE B

(5.) Measuring time to the nearest quarter hour or five minute mark on a clock [Correlation with Math objectives]	5. Teacher observation: Can students measure the amount of time it takes them to read a page of a book, walk to the bathroom and back, travel from home to school, eat lunch, etc., all to the nearest five-minute interval?
(6.) Using a thermometer to tell hotter from cooler temperatures and record specific readings (degrees Fahrenheit) [Correlation with Math objectives]	6. Teacher observation: Can students use a thermometer to measure such things as: -the temperature inside and outside -the temperature of soil at the surface and below the surface -the temperature of a car sitting in the sun
(7.) Using measuring cups to measure liquids to the nearest cup or half cup [Correlation with Math objectives]	7. Teacher observation: Can students use measuring cups to measure liquids, sand, sugar, etc.?
Classifying (8.) Organizing and classifying objects and information in categories, sequence, etc. (applied in content areas)	8. See Plants and Animals section.
Recording 9. Recording information in the form of sketches, maps, picture graphs, etc., and getting information from pictures and graphs made by others [Correlation with Math objectives]	9. Teacher observation: Can students present observations in the form of simple sketches or make a simple graph of information gathered? 
Using Equipment (10.) Using simple tools (hand lens, binoculars, tongs, tweezers, pulleys, etc.)	10. Teacher observation: Can students use simple equipment in classroom projects with care and safety?

SECOND GRADE C

C. SCIENCE AND SOCIETY	
(1.) Briefly describing the impact of at least two scientific advances of the past (e.g., the invention of the wheel; the discovery that some germs cause disease; etc.)	1. Choose at least two of these discoveries/inventions, and tell what effect each has had on our lives: -the discovery of fire -the development of crop-growing -the invention of the wheel -the discovery of harmful bacteria -the invention of clocks
2. Briefly describing the impact of at least two recent scientific/technological advances (e.g., computers, space travel, television, etc.)	2. Choose at least two of these more recent inventions, and tell how they have affected us: -the calculator -the microcomputer -space rockets and satellites -solar panels -nuclear power -radio and television -plastics
(3.) Telling about the life and work of at least two important scientists or inventors	3. Choose at least one important inventor/scientist, and tell a little about his or her life and work: -Alexander Graham Bell -Benjamin Banneker -George Washington Carver -Marie Curie -Amelia Earhart -Thomas Edison -Henry Ford -Jane Goodall -Johann Gutenberg -Matthew Henson -Mary Leakey -Garrett Morgan -Thomas Morse -Louis Pasteur -James Watt -Daniel Hale Williams -Wright brothers
4. Identifying some science-related jobs [maintained]	4. What are four jobs for which knowing a lot about science is important?

SECOND GRADE D

D. LIFE SCIENCE

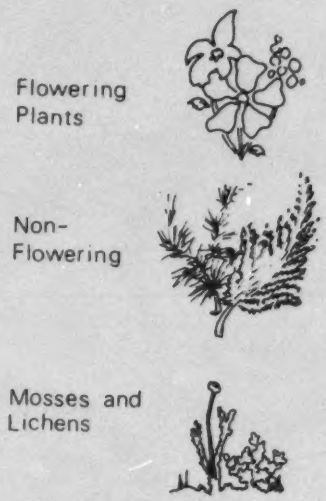
(1.) Identifying at least three characteristics of all living things (eating, breathing, reproducing, etc.)

1. How can you tell that something is alive? Name three ways that living things are different from non-living things.

Plants

(2.) Grouping a collection of plants into categories based on major types - flowers, bushes, trees, etc.

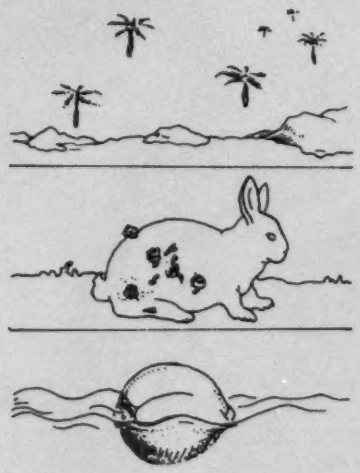
2. Teacher observation: Students should be able to group growing things into some of these categories:
   a. flowering woody plants
   b. non-flowering woody plants (trees and shrubs)
   c. soft-bodied herbs (flowering)
   d. soft-bodied non-flowering plants
   e. wild plants
   f. domestic or cultivated plants
   g. primitive non-flowering plants



(3.) Recognizing some of the main parts of plants and describing the function of each:
-roots (drawing up moisture from the ground)
-stem (holding up the leaves and flowers, carrying nutrients and water from the roots)
-flowers (producing seeds and fruit)
-seeds (producing the next generation)

3. What are the most important parts of a plant? What does each part do to keep the plant alive?

SECOND GRADE D

(4.) Identifying a few common vegetable foods as parts of plants (e.g., carrots as the root, lettuce and spinach as leaves, tomatoes as the fruit)	4. Tell what part of the plant each of these foods comes from: -carrots -apples -spinach -tomatoes -lettuce -potatoes
(5.) Predicting what would happen to a plant without water and sunlight	5. Could a plant survive without water? Without sunlight? How could you find out?
(6.) Describing the stages that a plant goes through in growing from a seed to a mature organism (germination, sprouting, seed production)	6. Tell how a plant grows from seed to maturity, and how it flowers and produces the next generation of plants. What are the main stages it goes through?
(7.) Describing how various plant species can move from place to place - seeds blowing in the wind or floating in water; birds carrying seeds; humans planting seeds; etc.	7. How can plants begin to grow on islands or places where they did not originally grow? Name some of the ways that a species of plant can "move" from one place to another. 
Animals (8.) Listing some similarities and differences between plants and animals	8. Name some of the ways that plants and animals are alike. Now name some differences between them. Check this list: -how they eat -what they eat -how they grow -how they move -where they can live -how they reproduce -how they die

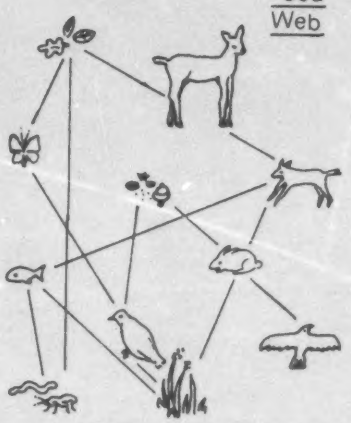
SECOND GRADE D

(9.) Categorizing various animals according to type (fish, amphibians, reptiles, insects, birds, mammals)	9. Put each of the animals below into one of these groups: FISH, AMPHIBIANS, REPTILES, INSECTS, BIRDS, MAMMALS. -robin -boa constrictor -ant -dog -gorilla -whale -lizard -crocodile -human -eagle -mosquito -frog
(10.) Describing some of the ways that living things protect themselves (running away, bluffing, fighting, color, camouflage, deceptive shape, acting wounded, keeping perfectly still, shells, pricklers, poison, imitating a poisonous species, smells, etc.)	10. Describe some of the ways that animals keep from being killed by predators. Name an animal that uses each method.
(11.) Describing the sequence of growth stages of a frog from egg to tadpole to adult	11. Tell all the stages that a frog goes through as it grows from a single cell.
(12.) Describing the ways that some common animals move (e.g., snake, horse, squid, inchworm, bird, flying squirrel)	12. From what you have seen of animals in real life and in movies and on TV, tell how the following animals move when they are just loafing, and when they are in a hurry: snakes, bears, cats, dogs, robins, herons, woodchucks, horses, flying squirrels, mice, foxes, grasshoppers, dragonflies, beetles, turtles.
13. Identifying some common wild animals found in the Boston area (sparrow, pigeon, seagull, squirrel, red fox, swans, white footed mice, Norwegian rats, chipmunks, ducks, robins, English sparrows, bluejays, redwing blackbirds, starlings, eastern grass snakes, box turtles, ants, sow bugs, bees, mosquitoes, butterflies, beetles, etc.)	13. Name as many wild animals that live in the Boston area as you can.

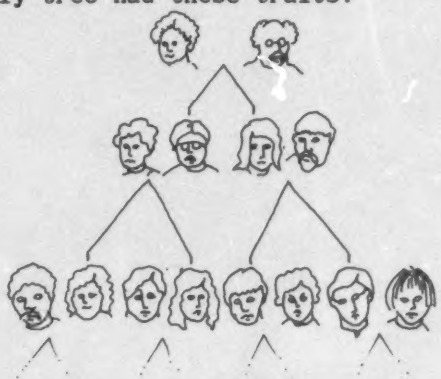
SECOND GRADE D

(14.) Distinguishing between animals usually found in the wild, on a farm, and in the city	14. Tell where each of these animals usually lives (some may live in more than one place): in the wild, on a farm, in the city. -cow -fox -eagle -gorilla -wolf -horse -sheep -chimpanzee -mouse -dog -cockroach -pig -pigeon -python -whale -lion
15. Naming some of the main differences between insects and other animals	15. Make a list of ways in which insects are different from other animals. Think of as many differences as you can.
(16.) Describing ways particular animals are adapted to survive in their habitat (webbed feet enable a duck to paddle; white fur camouflages a polar bear; a long neck allows a giraffe to get food from trees; etc.)	16. Choose at least one animal, and describe the features of its body that help it survive.
(17.) Naming some animals that eat plants and are in turn eaten by larger animals (e.g., rabbits, mice, fish, etc.)	17. Name some animals that eat plants and can be eaten by other animals. As an extra activity, put pictures of plants and several animals on a piece of cardboard and draw lines showing how animals feed on the plants and on each other.

SECOND GRADE D, E

	Food Web 
18. Exploring animals' needs beyond those of mere survival and reproduction - e.g., do animals feel pain? fear? happiness?	18. Think about the animals you have known, the animals you have read about, and the animals you have watched in movies and on television. Do you think animals have feelings like humans? What makes you say so?
Heredity 19. Recognizing that each kind of living thing can only reproduce something like itself (like begets like)	19. Can a dog give birth to a wolf? Can a whale give birth to a dolphin? Why?
E. HUMAN BIOLOGY AND HEALTH 1. Listing some similarities between humans and animals (some senses, the same basic internal organs, need for food, water, and air, etc.) and some major differences (upright posture, more skillful hands, larger and more highly developed brain, etc.)	1. Name some ways that humans and animals are the same. Now think of some ways they are different.
2. Describing what happens to the food we eat (it is broken down in the stomach and intestines into chemicals that our bodies can absorb and use; the rest is eliminated)	2. What happens to the food we eat? Describe the journey of a piece of food through your system.
3. Describing the general function of the circulatory and respiratory systems of the human body	3. How does blood move around our bodies? Why is it important for the blood to keep moving? How does air move in and out of our bodies? Why is it so important that we keep breathing air in and out?

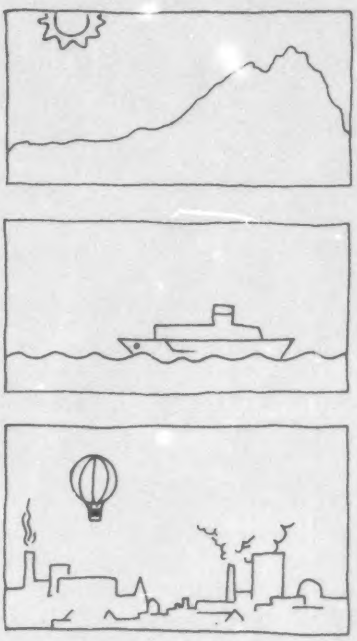
SECOND GRADE E

(4.) Comparing the main physical characteristics of humans at different stages of their lives: infant, toddler, child	4. How were you different as a new-born baby than you were when you were 1-1/2 years old? Than you are now? Make a list of the differences?
5. Knowing the number of baby teeth (28) and adult teeth (32), and identifying the functions of baby teeth (chewing solid food, guiding permanent teeth into place)	5. How many baby teeth do children have once they have all come in? How many teeth do grown-ups have (if none have been pulled out)? Why are baby teeth important?
6. Naming some traits we may inherit from our ancestors - hair color, eye color, complexion, height, build, etc.	6. Think about where you may have inherited some of your special traits, like your hair color, eye color, body build, nose shape, etc. Who in your family tree had these traits? 
Health (7.) Describing some of the conditions humans need to survive (food, air, water, sleep, shelter, protection, clothing, companionship, etc.)	7. Make a list of all the things humans need in order have to survive.
8. Describing some of the effects of insufficient exercise and sleep	8. What happens to people's bodies when they do not get enough exercise? How do people act differently when they don't get enough sleep?
(9.) Recognizing that eating a variety of foods is important to good health; identifying five food groups, the first four of which are vital to a balanced diet: -fresh fruits and vegetables -whole grain breads and cereals -dairy products (milk, butter, cream) -meat, eggs, nuts, beans, etc. -foods containing little but fat and sugar ("junk foods"): candy, cookies packaged chips, soft drinks, etc.	9. a. Would it be healthy to eat only carrots for breakfast, lunch, and dinner? b. What are four kinds of foods that it's important for people to eat every day? c. What are some "junk foods" that don't do much for the growth and development of our bodies?

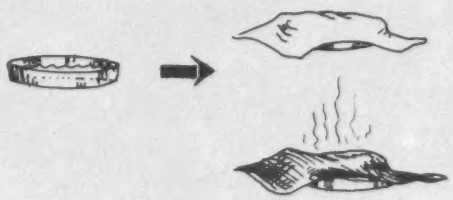
SECOND GRADE E

(10.) Describing the process of tooth decay (acids produced in the mouth when bacteria attack our food), and steps that can be taken to avoid it (fluoridated water, brushing after meals, more thorough periodic cleaning of teeth by a dentist)	10. What makes teeth decay (get cavities)? Name three ways that people can reduce the number of cavities they have.
11. Describing the symptoms of some common childhood illnesses (measles, cold, etc.), and the treatment usually prescribed	11. Tell what happens to a person's body with each of these, and what he or she should do to get well: -measles -cold -flu (influenza) -chicken pox -mumps -poison ivy -food poisoning
(12.) Naming some ways that disease germs are carried from one person to another (sneezing, coughing, unwashed hands, touching food, kissing, etc.)	12. What are some ways you can get disease germs from another person? See if you can think of at least five ways.
Safety (13.) Identifying substances harmful to the human body (poisons, corrosives, lead paint, asbestos, mercury, spoiled food, tobacco, alcoholic beverages drunk in excess, etc.), and describing their effects	13. Make a list of at least five substances that are harmful or dangerous to the human body. Tell what each one does to the body.
(14.) Identifying some major safety hazards for this age group, and describing ways of minimizing the risks of each one: -pedestrian accidents -injuries in car accidents (seat belts) -bicycle accidents -fires in buildings (prevention and escape) -sharp tools and utensils -poisons and corrosives -swimming and other sports -miscellaneous	14. Make a list of at least five ways that children your age can be seriously hurt or killed. Then tell some ways that each danger can be avoided.

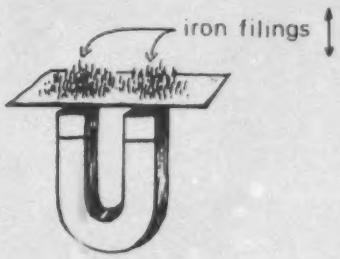
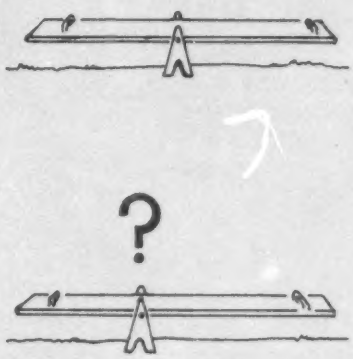
SECOND GRADE F

F. PHYSICAL SCIENCE **Matter** (1.) Recognizing that air takes up space, and that most things that we regard as empty are actually filled with air	1. What holds birds, balloons (gas-filled), and airplanes up? What is really inside an "empty" box of cereal?
(2.) Categorizing matter by important physical characteristics: solid, liquid, or gas; texture, color, density, etc.	2. Put each of the items on the list below into one group: SOLID, LIQUID, or GAS. -water -helium -ice -mercury -steam -iron -sand -air -wood Teacher observation: Can students group other objects according to their roughness or smoothness, shape, color, weight, etc.? 
3. Naming some common things that are not matter (light, heat, electricity, radio waves, ideas, dreams, etc.)	3. Make a list of some things that you cannot touch or weigh and that don't take up any space in the world (for instance, magnetism).
(4.) Identifying the different forms that water can take at different temperatures (ice, snow, liquid, steam, invisible vapor)	4. Make a list of all the different forms that water can take (think of a winter day). You should be able to think of at least five!

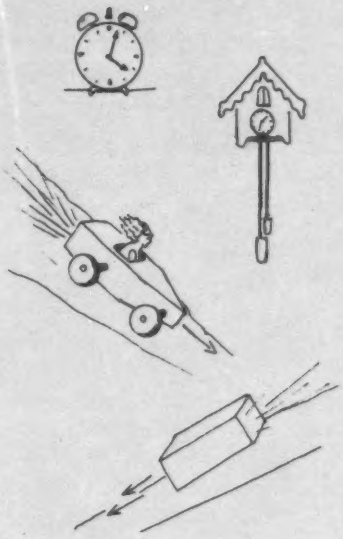
SECOND GRADE F

(5.) Describing the characteristics of things that sink and float in water	5. What kinds of things sink in water? What kinds of things float in water?
Energy 6. Giving examples of heat, light, and motion energy	6. There are many kinds of energy. Give an example of each kind: heat, light, motion, others.
7. Naming the immediate source of energy that makes something move - e.g., a spring making a wind-up toy move; gasoline making a car run; electricity making a trolley run; wind making a sailboat move; leg muscles making a bicycle move; etc.	7. Anything that moves has to get its energy from somewhere. What is the source of energy in each of these? -a wind-up toy car -a bus -a rocket -a human -an electric trolley -a sailboat
8. Recognizing that dark-colored objects get hotter than light-colored objects exposed to sunlight	8. Two cars are sitting in the sun with their windows rolled up. One car is black and the other is light blue. Which car will get hotter inside? Why? If you covered a pan of water with a dark cloth and left it in the sun, would it be hotter or cooler than a pan of water with a white cloth over it? 
(9.) Listing some sources of warmth and heat (the sun, oil, firewood, electricity, etc.)	9. Make a list of ways we get heat to cook and keep warm. What are the most widely used fuels here in Boston?
Magnetism (10.) Predicting whether or not a magnet will stick to various objects	10. From your own experience with magnets, make a list of things you know magnets will stick to, and another list of things they will <u>not</u> stick to.

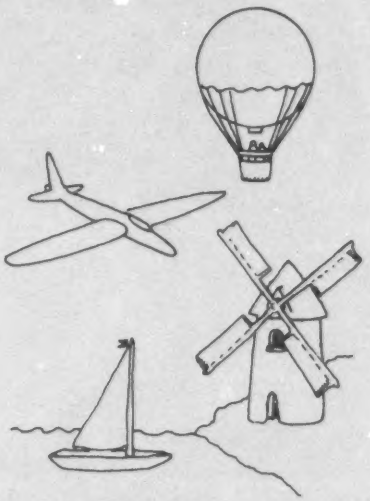
SECOND GRADE F

11. Recognizing that magnetic force penetrates some materials better than others (cardboard; thick wood)	11. Can magnetism act through a piece of cardboard? A piece of glass? A thick door? 
Mechanics 12. Predicting what is needed to balance an equal-arm balance (such as a see-saw), in terms of moving weights and moving the fulcrum	12. The first see-saw is balanced. What do you have to do to make the second one balance (<u>without</u> moving the see-saw?) 
13. Identifying ways of using three basic mechanical devices (a lever, a wheel and axle, or an inclined plane) in an everyday situation (e.g., using a long stick as a lever to move a rock)	13. Think of a clever way of saving work doing each of these pieces of heavy work: -lifting a boulder a few inches off the ground so you can get a hundred-dollar bill out from under it -carrying a very heavy suitcase down a long corridor at the airport -getting an enormous sofa up into the back of a moving van
Forces 14. Recognizing that in order for a stationary object to move, there must be a force pushing or pulling it; or there must be some energy inside it (like a spring in a wind-up car) that makes it move	14. Where is the force or energy coming from in each of these? -a wind-up clock -a cuckoo clock with weights -a soap-box derby car racing down a hill -a block of wood sliding down a ramp

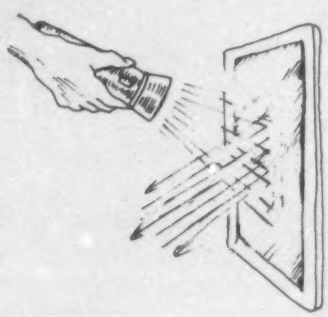
SECOND GRADE F

	
15. Recognizing that friction can make it difficult to slide an object on a surface, and identifying surfaces that have varying amounts of friction (a smooth, polished floor versus a concrete floor)	15. Is is easier to drag a box over a concrete floor or a smooth, waxed floor? Why? Put these surfaces in order from the easiest to the hardest to pull things over: -a thick carpet -a rough wood floor -a dirt floor -a concrete floor -a marble floor -a floor covered with grease
(16.) Recognizing that the Earth's gravity is a force that pulls everything down toward the center of the planet	16. Why don't the objects on the Earth's surface fly off into space? What holds them down? What makes things fall straight down when we drop them?
(17.) Recognizing that the wind can be a force that moves things and does work, and giving examples of how it can move objects	17. Tell how the following get the energy that makes them move: balloons, sailboats, gliders, windmills. Can you think of other examples of the way the wind can move things?

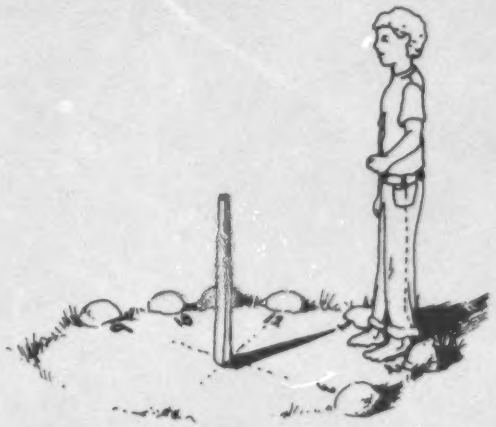
SECOND GRADE F

	
18. Recognizing that when objects are dropped, the force of impact becomes greater as the distance they fall increases (Note: there comes a point where the speed no longer increases)	18. Two girls jump off diving boards into a swimming pool. One jumps off the low board, the other off the high board. Which one will hit the water harder? Why?
19. Recognizing that it is the steepness of a board that increases the speed with which a ball or toy car rolls down it	19. A boy has a long board and is rolling a toy car down the board. What can he do to the board to make the car roll faster?
Sound 20. Giving examples of situations where sound can travel through materials (e.g., water, glass, a wall, a metal pipe, etc.)	20. Can sound travel through water? Through wood? Through metal? Give examples of each.
21. Recognizing that vibration is a fast backward and forward movement that produces sound, and giving some vivid examples (e.g., a guitar string, the head of a drum, etc.)	21. What does a guitar or piano string or the head of a drum have to do to make sound? Put your hand over your throat while you are talking; what is the word for what you feel? What are some other things that move this way when they make sound?

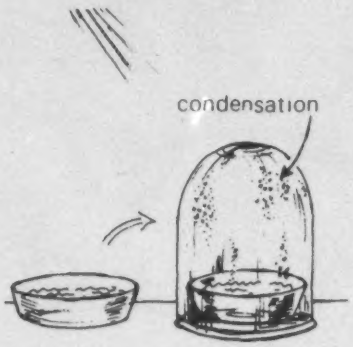
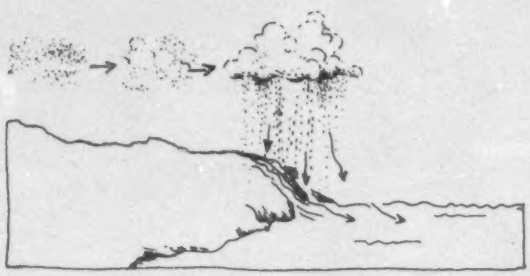
SECOND GRADE F

22. Categorizing sounds according to whether they are soft or loud, near or far, harsh or smooth, high-pitched or low-pitched, etc.	22. Think of a few sounds you have heard that fit into each category: -loud -soft, whispering -harsh -smooth -high-pitched -low-pitched -crashing -tinkling -screeching -ear-piercing -thundering or booming -far-away
23. Describing what has to be changed to make a higher- or lower-pitched sound in these situations: -tapping a glass with some water in it -blowing across the top of a bottle with some water in it -plucking a rubber band that is stretched between your fingers	23. If you are making one note by tapping a glass half-filled with water, how can you make the note higher? How can you make it lower?
Light 24. Describing the effect that a mirror has on a beam of light from a flash-light	24. Make a sketch of what happens to the rays of light when you shine a flash-light into a mirror. Can you predict what will happen to the rays if you shine them at the mirror from a particular angle? 
25. Recognizing the the image we see in a mirror is the reverse (left for right) of what is reflected	25. If you look at yourself in a mirror and raise your right hand, does your reflection also raise its right hand? Why?

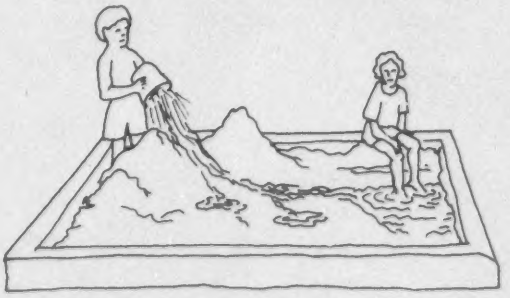
SECOND GRADE F, G

26. Recognizing that, when you are standing outdoors on a sunny day, the length of your shadow depends on the angle of the sun, and predicting the time of day when your shadow would be shortest and longest	26. At what times on a sunny day will your shadow be longest? When will your shadow be shortest? [Enrichment: can you describe a way to make a simple sundial by using a stake and rocks?] 
(27.) Naming the combinations of primary colors that produce secondary colors (e.g., blue and yellow make green)	27. What two primary colors make green? What two primary colors make purple? What two primary colors make orange?
G. EARTH SCIENCE	
(1.) Recognizing that the sun is the main source of energy for the Earth	1. What is the main source of energy on Earth? Where did most of the heat energy on Earth come from?
Weather (2.) Recognizing that the sun heats the air, water, and land on the Earth, and that at night all three cool down	2. What is the effect of the sun on the soil, water, and air during the day? What happens to their temperature at night? Can you think of an experiment to show that what you say is true?
(3.) Describing some ways that the weather affects our lives - which activities are possible in certain weather conditions and which aren't	3. Why does each of these people listen to the weather forcast? Why is the weather important to him or her? -a farmer -a sea captain -an airline pilot -a baseball manager -a person planning a picnic

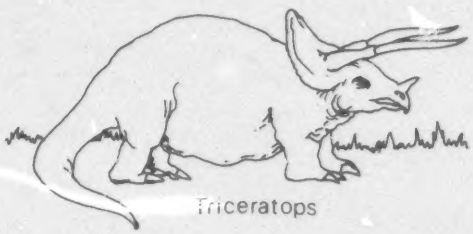
SECOND GRADE G

4. Describing evaporation as the process by which water is turned into an invisible vapor, most of which then rises up in the atmosphere and turns into visible clouds	4. What is evaporation? What happens to water in this process? Can you design an experiment to show how evaporation works? 
(5.) Describing the journey of a drop of water as it evaporates from a puddle, rises up and becomes part of a cloud, falls to the Earth as rain, collects in a puddle, is evaporated again, etc. (the water cycle)	5. Tell what happens to water from a pond as it is evaporated from the ground. Tell the whole story of its journey back to Earth. 
(6.) Recognizing that clouds are made of tiny droplets of water or ice, and that under certain conditions, these droplets will fall to the ground as rain or snow	6. What are clouds made of in warm weather? What are they made of in very cold weather? Why do some clouds pass overhead without dropping any rain or snow? What causes rain or snow to fall from clouds?
(7.) Describing some different kinds of clouds (puffy "fair weather" clouds; dark storm clouds; high wispy clouds)	7. Describe or draw pictures of some different kinds of clouds you have seen. Which are the most likely to produce rain?
8. Describing the difference between the way you feel on a hot humid day and a hot dry day	8. Tell how you feel on a hot, humid day. How is it different from the way you feel on a hot, dry day? How does your skin feel different?

SECOND GRADE G

(9.) Describing weather conditions over a period of days	9. Teacher observation: Students should keep a record of different weather conditions over a period of days or weeks. These can include: -sky conditions -temperature -amount of rain or snow -whether the air is humid or dry -amount of wind It would be interesting to have different students compare notes, and compare their observations with the predictions made by local weather forecasters.
Geology 10. Recognizing that soil is made up of tiny broken pieces of rock and decaying organisms, and that this organic matter is very important to the growth of some plants and animals	10. What is in soil that is most imporant to growing plants?
11. Recognizing that the soil in various places looks and feels different because it is has different kinds of broken-up rock and varying amounts of organic matter in it	11. Why does the soil from different places look so different (for instance, some soil looks dark brown, other soil looks reddish)?
12. Recognizing that soil holds water, and that some kinds of soil hold more water than others, making them better environments for plants	12. What happens to water when it falls onto the ground? Do all kinds of soil hold water as well? [Enrichment: Can you devise an experiment to show that some kinds of soil hold water better than others? If you pour the same amount of water into four different kinds of soil and let them sit....]
13. Describing ways in which topsoil can be washed away, and the effects of this process on a hillside or field	13. How does good rich soil sometimes get washed away? When this happens, what does it do to the plants growing in the area? [Can you show how erosion works in a sandbox?] 

SECOND GRADE G, H

14. Recognizing that there are many kinds of rocks, and grouping a collection of rocks according to hardness, texture, color, etc.	14. If you had to guess, how many different kinds of rocks would you say there are in the world? Put some rocks in groups according to their hardness, roughness, coloring, etc.
15. Identifying some of the forces that change the surface of the Earth: earthquakes, volcanoes, windblown sand, freezing water, etc.	15. What forces have changed the surface of the Earth over the years?
Prehistoric Life 16. Identifying fossils as evidence of the existence of creatures that lived millions of years ago	16. What can you find in the ground that shows different kinds of life that were on the Earth millions of years ago?
(17.) Describing the age of dinosaurs - some of the major reptiles of that era, their living and eating habits, etc.	17. How long ago did the dinosaurs roam the Earth? What did some of them look like? What did they eat? Can you draw a picture of one?  Triceratops
H. ASTRONOMY (1.) Describing some of the objects in space: the sun, moon, planets, and stars	1. What are the biggest objects in space near the Earth? What do they look like? Could people live on them?

SECOND GRADE H

(2.) Identifying the sun as a star - one that is closest to us and therefore appears much bigger than the others in the sky	2. What is the closest star to the Earth? Why does the sun appear so much larger than the other stars? If the sun were as far away as the other stars in the sky, what would it look like to us?
(3.) Recognizing that, even when we can't see the stars during the daytime, they are still shining; and that when we can't see the sun at night, it is shining on the side of the Earth that is facing it	3. What happens to the stars during the daytime? Why can't we see them? Where is the sun shining when it is night in Boston?
(4.) Identifying the spinning of the Earth on its axis once a day as the reason that we have day and night; in other words, although the sun seems to move across the sky every day, it is really the Earth's movement that accounts for the sun's "rising" and "setting"	4. What causes day and night? When the sun "moves" across the sky during the day, what is really happening?
5. Distinguishing the spin of the Earth on its axis (which happens once a day) from the circular orbit of the Earth around the sun (which takes an entire year)	5. About how long does it take the Earth to spin around once on its axis? About how long does it take the Earth to make one orbit all the way around the sun?

SECOND GRADE H, I

(6.) Knowing that the sun rises in the east and sets in the west, and identifying the side of the school building that the sun shines on in the morning and afternoon [See objective H-4 above; the use of "rises" and "sets" is somewhat loose here.]	6. In what direction does the sun rise: north, south, east, or west? In what direction does it set? From this, can you figure out which side of your classroom faces east?
(7.) Describing how the Earth orbits around the sun with several other planets (using a sketch to illustrate)	7. What other planets orbit the sun with the Earth? What is the shape of the orbits of the planets? Make a sketch to show.
(8.) Describing the environment on the moon (no air, no water, no life), and giving some reasons it would be difficult for people to live there	8. What is it like on the moon? What is missing that we have on Earth? Why is it very difficult for humans to stay alive on the moon?
(9.) Describing the preparations that astronauts must make before they can travel into space	9. What do astronauts need to survive in space? Make a list.
I. SCIENCE READING	
(1.) Reading at least three of the science books or magazines listed at the end of the third grade objectives, either as part of the individual project (objective A-2), or as a separate activity	1. Teacher observation and record-keeping

THIRD GRADE

A. SCIENCE EXPERIENCES

(1.) Carrying out and reporting on at least one hands-on science experiment or project, working individually or in a small group. The topics of the experience should be chosen by each student, drawing on the content for this grade level (see sections C - H) or other topics of interest to students. The experience is open-ended in terms of content, but should incorporate as many of the following general science processes as possible: a. Stating what you want to find out in clear and precise terms b. Planning the project or experiment, deciding what equipment and materials are needed, and gathering them c. Stating a hunch about what the result of the experiment might be d. Carrying out the experiment or project e. Observing and describing what happened, using measurement instruments to get precise readings if necessary f. Keeping records of data gathered in the form of notes and drawings g. Sorting, comparing, and classifying the information gathered, looking for patterns and regularities, similarities and differences h. Thinking about the data you gathered, and reaching some logical conclusions i. Presenting the conclusions in oral, written, or graphic form	1. Teacher observation: By the end of the year, has the student completed and reported on at least one hands-on science experience which includes most of the science processes? Some possible experiences: - observing daily changes in the growth of a plant - observing the behavior of an animal - collecting data on weather and/or seasonal changes - recording the different positions of the sun's shadows at the same time of day over the course of two or three weeks - recording one's own growth or the growth of other children
(2.) Using books (see section I), interviewing, field trips, or other experiences to find out a great deal about at least one topic, and presenting a report on that topic	2. Teacher observation: Has the student chosen a topic, made a thorough investigation of it, and presented a written report? Some possible topics: - reptile study - amphibian study - bird study - wild mammal study - endangered species - forestry conservation - home computers - paper manufacturing

THIRD GRADE B

B. SCIENCE SKILLS AND PROCESSES

Observing

1. Observing carefully; noticing such details as size, shape, color, texture, weight, taste, smell, position, time taken, etc. (using a magnifying glass or elementary microscope where necessary)

Measuring

2. Identifying the appropriate measuring tool and measuring unit for a task [Correlation with Math objectives]

3. Measuring length to the nearest half inch [Correlation with Math objectives]

4. Measuring weight in ounces or pounds [Correlation with Math objectives]

5. Measuring time to the nearest minute [Correlation with Math objectives]

6. Measuring temperature in degrees Fahrenheit [Correlation with Math objectives]

7. Measuring volume in cups, pints, quarts, or gallons [Correlation with Math objectives]

8. Estimating length, weight, temperature, and time when rough readings are appropriate [Correlation with Math objectives]

Classifying

9. Organizing and classifying objects and information in categories, sequence, etc. (see content objectives)

1-10

These skills and processes should be applied in the Science Experiences, Life Science, Human Biology and Health, Physical Science, Earth Science, and Astronomy sections. Specific right-hand column examples are not given in order to encourage the application of the skills to all content areas. The substantial overlap of these skills with those in the mathematics curriculum document makes it possible to teach many science and mathematics skills simultaneously.

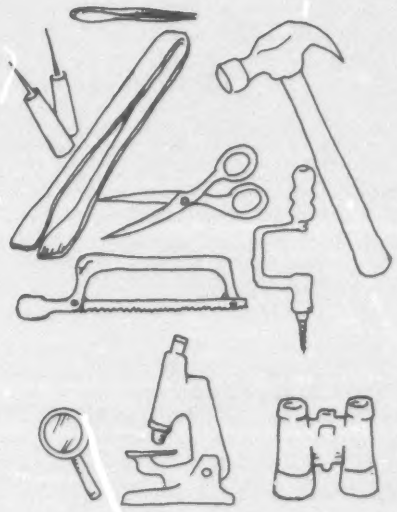
THIRD GRADE B

Recording

(10.) Recording information in the form of sketches, picture and bar graphs [Correlation with Math objectives], and notes; and interpreting pictures, graphs, and observations by others

Using Equipment

(11.) Using simple science tools - a hand lens, magnifying glass, binoculars, etc.



11. Below are some possible instruments and tools:
-hand lens
-magnifying glass
-microscope
-telescope or binoculars
-thermometer
-stopwatch
-tuning forks
-weather vane
-anemometer
-barometer
-hygrometer
-hand drill
-saw
-T-square
-tape measure
-meter or yardstick
-hammer
-graduated glass
-balances (single or double pan or beam)
-vise
-plane
-tweezers
-pliers

How Scientists Work

12. Describing how at least one famous scientific discovery was made, describing the method the scientist(s) used and the role of persistence, cooperation, luck, etc. in success

12. Teacher observation: Has the student reported on at least one discovery in some detail? The focus should be on reporting the human story behind the discovery, noting the process that scientists went through.

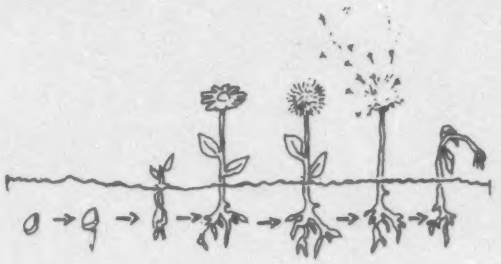
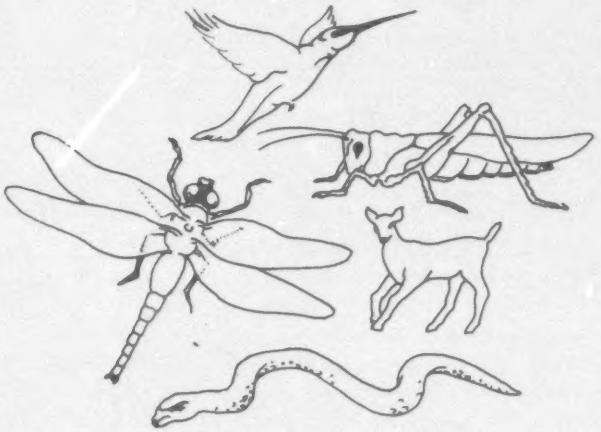
THIRD GRADE C

C. SCIENCE AND SOCIETY	
1. Describing the impact of at least two scientific/technological advances of the past (e.g., the invention of the telescope; the development of the airplane; the building of dams; the invention of the radio; etc.)	1. Choose at least two important inventions that were made long ago. Tell how they have changed our lives. How would things be different for us today if these inventions hadn't been made?
2. Describing the impact of at least two recent scientific/technological advances	2. Choose at least two important inventions that were made in the last twenty years. Tell how they have changed our lives. How would things be different for us today if these inventions hadn't been made?
3. Describing at least one current scientific or technological issue (examples from previous years could include the space shuttle, acid rain, Three Mile Island)	3. Tell about a science story that has been in the news this year. Why was it important?
4. Naming several important scientific inventors, and describing their major contributions and some biographical details about them	4. Tell about the most important work of at least three of these well-known scientist/inventors: -Johann Gutenberg -Matthew Henson -Earnest E. Just -Mary Leakey -Guglielmo Marconi -Garrett Morgan -Thomas Morse -Isaac Newton -Florence Nightingale -Louis Pasteur -James Watt -Daniel Hale Williams -Granville Woods -Wright brothers

THIRD GRADE C, D

5. Describing what is involved in being a scientist or inventor	5. What is involved in coming up with a new scientific invention or discovery? How do scientists and inventors spend their time?
D. LIFE SCIENCE	
(1.) Grouping a miscellaneous list into living and non-living things (keeping in mind three essential characteristics of living things: breathing, eating, and reproducing)	1. Put these things into two groups, one of living and the other of non-living things: -a human -a mirror -a piece of paper -a tree -a leaf on the ground in fall -a computer -a calculator -an electric typewriter -a telephone -a dog -a bush -a rock
Plants (2.) Grouping plants into major types and describing the characteristics of each group (edible and inedible, large and small, etc.)	2. Make a list of plants in one or more of these groups: -edible, inedible, and poisonous -large and small -flowering and non-flowering -useful to humans, not useful to humans
(3.) Describing the "teamwork" that exists between the different parts of a plant - the roots, stem, leaves, etc.	3. What do the roots of a plant do to keep it alive? What does the stem do? What do the leaves do? Could a plant stay alive without one of these parts doing its job?
(4.) Describing the results of depriving a plant of light or water	4. What happens if a plant doesn't get enough water or light? Can you think of an experiment to test what you say?
(5.) Describing the stages in the life cycle of plants (seed, germination, growth, reproduction)	5. Tell about the stages that a plant goes through as it grows from a seed. Can you make drawings to show each stage?

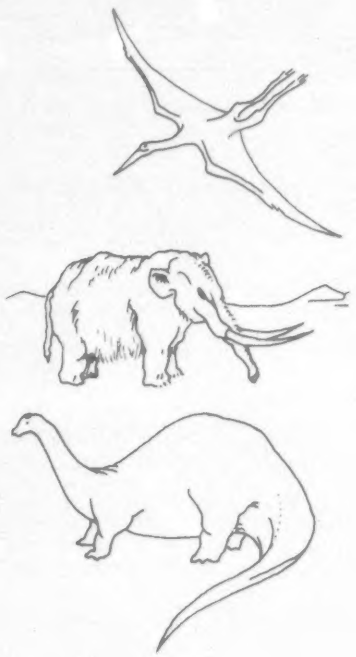
THIRD GRADE D

	
(6.) Describing methods of growing plants without planting seeds (cuttings)	6. How can a plant be grown without planting a seed? Describe how it is done.
Animals (7.) Classifying animals according to certain criteria: predator and prey; plant eaters and hunters; vertebrates and invertebrates; those that feed and protect their young and those that do not, etc. 	7. List animals that fit into some of these groups. Can you find animals for all of them? -predators or hunters -prey -plant eaters -meat eaters -vertebrates -invertebrates -those that protect and feed their young -those that do not protect and feed their young -those that have the same mate for life -species where the father cares for the young -species where the mother kills the father shortly after the young are born -those that migrate every year -those that hibernate in the winter
(8.) Describing how some parts of an animal's body help it survive in its environment (e.g., a lion's coloring and massive teeth; an eagle's sharp vision, a giraffe's long neck, a gorilla's sharp eyes, a monkey's prehensile tail, a deer's muscular legs, an owl's silent flight, a bat's sonar guidance system, a dolphin's keen hearing, etc.)	8. Animals' bodies seem to be specially designed to keep them alive. Choose an animal and tell how special parts of its body help it survive.

THIRD GRADE D

(9.) Distinguishing between animals that lay eggs (reptiles and birds) and those that bear their young without eggs (mammals), and giving examples of each	9. Make a list of animals that lay eggs with their young inside them. Now make another list of animals that give birth to their young not in eggs.
10. Describing the basic stages of the growth of a butterfly	10. Tell about the stages a butterfly goes through in its life. Illustrate with drawings if you can.
(11.) Given a common animal, describing its way of moving around (crawling, flying, etc.), the way it communicates (noises, body movements), and how its young are born	11. Choose an animal you have learned a lot about and tell: -how it moves around -how it communicates -how its young are born -other interesting information
(12.) Distinguishing between domestic animals, which have become dependent on humans for survival, and wild animals	12. Name some domestic animals (those who wouldn't survive unless humans took care of them). Now think of some wild animals. What are the main differences between them?
13. Exploring animals' needs beyond mere survival and reproduction - e.g., do they feel pain, fear, happiness? [maintained]	13. Do animals feel pain? Do they feel fear? Do animals get worried? Do they feel happiness and unhappiness? Give some examples that prove your answers are correct.

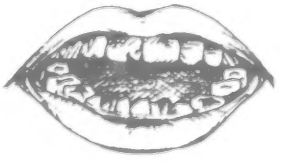
THIRD GRADE D

Ecosystems (14.) Describing a simple food chain: green plants use sunlight, water, and nutrients in the soil; small animals eat the plants; and larger animals (predators) eat the small animals (prey)	14. Describe a food chain, starting with sunlight and ending up with food that you eat. Think about including these parts: -sunlight -small animals -plants -large animals (predators) -water -nutrients in the soil
(15.) Recognizing that animals breathe in oxygen and breathe out carbon dioxide, while plants absorb carbon dioxide and give off oxygen	15. What gas is given off by plants which animals must breathe to stay alive? What gas do animals breathe out which plants need to stay alive?
(16.) Recognizing that each environment (a pond, forest, swamp, desert, etc.) has its own population of living things, and that the amount of food and/or water available (as well as the presence of predators, the climate, etc.) puts strict limits on the number of particular kinds of plants and animals that can survive	16. Can the animals living in one place (like a swamp, for instance) suddenly move to another place (like a desert)? What keeps the number of animals in one place from getting too large?
Evolution (17.) Identifying fossils as evidence of plants and animals that once lived on the Earth but are now extinct	17. How do scientists know about animals that lived on the Earth long ago and are now extinct? 

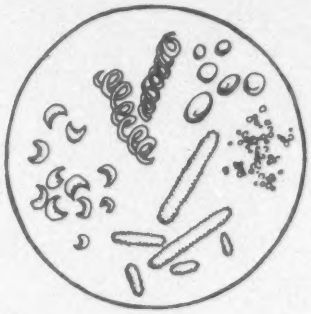
THIRD GRADE D, E

(18.) Recognizing that many living things have become extinct (including dinosaurs) because their adaptations no longer worked in their environment, or because they were killed off by predators or humans	18. Why do some animals become extinct? Give some theories and examples.
19. Recognizing that each new plant, animal, or person produced by sexual reproduction is unique; although it is like its parents, it is different from them and from its siblings in certain ways (the only exception is identical twins)	19. Why are almost all living things different from their parents, brothers, and sisters? What is the exception (living things that are just the same)?
E. HUMAN BIOLOGY AND HEALTH **Anatomy** (1.) Recognizing that the skeleton and muscles hold our bodies upright and move them around	1. What is the function of our skeleton and muscles? What would the human body be like without a skeleton? What would our bodies be like without muscles?
2. Comparing the human skeleton to the skeleton of an animal	2. How is the skeleton of a human different from the skeleton of a dog? Are there ways in which the two skeletons are the same - bones which are almost the same?
(3.) Describing the function of these three systems in our bodies: digestion, which turns food into the chemicals the body needs; respiration, which takes in oxygen and releases carbon dioxide; and circulation, which pumps blood to all parts of the body	3. What does each of these systems do in the human body? -the digestive system -the respiratory system -the circulatory system
(4.) Describing some differences between people at different life stages: fetus, newborn, toddler, child	4. What are the most important changes in humans between each of these stages of development? -fetus to newborn baby -newborn baby to toddler -toddler to child

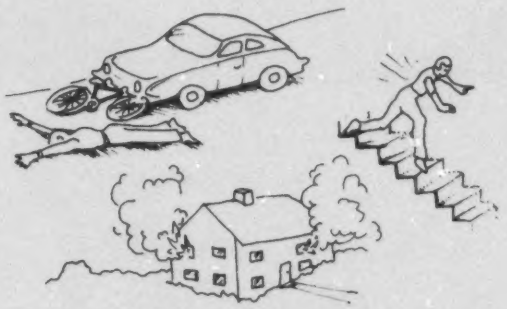
THIRD GRADE E

(5.) Identifying the timing of the emergence of baby teeth (first year of life) and of permanent teeth (age six to twenty)	5. When do babies get their first teeth? When do baby teeth give way to grown-up teeth? Does everyone get teeth at the same ages?
6. Identifying the different kinds of human teeth: canines, incisors, and molars	6. What are the three different kinds of grown-up teeth?
(7.) Distinguishing beween the traits we may inherit from our ancestors (eye color, complexion, height, etc.) and those we develop during our lives (skills, knowledge, etc.)	7. Make a list of things you have inherited from your parents and ancestors. Now make a list of things you have learned in your lifetime, that are <u>not</u> inherited.
8. Distinguishing between some voluntary and involuntary functions of the human body (e.g., speaking, walking, running versus breathing, digesting, circulating blood)	8. Make a list of things your body does without your having to think about it (they keep going even when you are asleep). Now make a list of things your body will do only when you tell it to.
(9.) Identifying the basic needs of the human body for survival and growth - food, air, water, sleep, exercise, etc.) [maintained]	9. What are the things your body <u>must</u> have to stay alive?
Nutrition (10.) Identifying foods in the five basic food groups, and describing a day's meals and snacks that have foods from at least the first four groups: -fresh fruits and vegetables -whole grain breads and cereals -dairy products - milk, butter, cream -meat, eggs, nuts, beans, etc. -foods with little but fat and sugar ("junk foods") - candy, cookies, chips, soft drinks, etc.	10. Give examples of foods in each of the five groups. Now tell which of the first four groups is not represented in the food George ate in one day: -breakfast: cereal, milk -lunch: cheeseburger, potato chips, Coke -snack: cookies, Coke -dinner: hot dogs and beans, bread -snack: ice cream
(11.) Giving the reasons some people's teeth decay faster than others' (heredity, unfluoridated water, irregular brushing and dentist's care, type of foods eaten, etc.)	11. Why do some people have more tooth decay than other people? 

THIRD GRADE E

Health (12.) Describing how disease germs enter our bodies (inhaled, eaten, introduced through cuts), and some effects they have on us (high temperature, fatigue, aches, nausea, etc.)	12. Name some of the ways disease germs can get into your body. What are some ways you know when you are sick?
13. Recognizing that many kinds of germs are not harmful and perform important jobs in our bodies and all around us	13. Are all germs harmful to people? Give an example. 
(14.) Describing what a doctor does during a regular check-up, and the role of inoculations in preventing diseases	14. When you go to a doctor for a regular check-up, what does he or she look at and do? How do inoculations (shots) help us?
Safety (15.) Identifying substances that harm the human body, and what their effects are: -poisons and corrosives -spoiled foods; botulism -asbestos -mercury -lead paint -tobacco -alcohol -marijuana and other mind-altering drugs	15. What are some substances that are harmful to the human body? Name as many as you can think of.
(16.) Identifying some important safety hazards for this age group, and describing ways of minimizing the risks of each one: -pedestrian accidents -injuries in car accidents (seat belts) -bicycle accidents -fire (prevention and escape) -power tools (saws, drills, sewing machines) -swimming and other sports	16. How are children your age sometimes hurt or killed? Make a list of as many ways as you can think of, and then write by each one things you can do to cut down your own risk.

THIRD GRADE E, F



F. PHYSICAL SCIENCE	F. PHYSICAL SCIENCE
Matter (1.) Giving examples of three forms of matter: solid, liquid, and gas	1. Make a list of things that fall into each group: a. solid b. liquid c. gas
(2.) Identifying the different forms water can take - liquid, solid, and gas	2. What three forms can water take? What form does it take at room temperature? What form does it take on a very cold day? What form does it take when it is boiled?
(3.) Recognizing that air is made up of a mixture of gases	3. True or false: Air is made up of only one gas, oxygen. Can you think of an experiment to prove your answer is right?
4. Describing ways we can tell that air is a real substance and occupies space (the tension on a balloon, a car's tires being held up, birds and planes being held up as they fly, the damage of hurricanes, etc.)	4. If you can't see it, how can you be sure that air really exists? Describe a way of proving to a first grader that air is real.
(5.) Giving examples of the way things expand when they are heated or cooled (railroad rails, sidewalks, etc.)	5. Many things expand (get a little bigger) when they are heated up. Can you think of some examples?
Energy (6.) Recognizing that the sun is a major source of energy on Earth	6. What is the most important source of energy for the planet Earth?

THIRD GRADE F

7. Recognizing that fossil fuels (coal, oil) were formed millions of years ago when decaying trees and animal bodies were compressed under ground	7. How were fossil fuels (coal, oil, etc.) formed millions of years ago?
8. Identifying the source of our electricity and oil in Boston (generators; oil tankers, mainly from the Middle East)	8. From what part of the world does most of the oil that people use in Boston come? Where is our electricity made?
9. Giving examples of one kind of energy being changed into another (electricity into heat in a toaster; light into heat in a rooftop solar collector; motion into heat in your hand as you slide down a pole)	9. One kind of energy is often turned into another. Give an example of: a. electrical energy being turned into heat energy b. electrical energy being turned into light energy c. motion energy being turned into heat energy
Magnetism 10. Distinguishing between objects to which magnets do and do not stick (glass, wood, steel, aluminum, etc.), and making generalizations about which materials are magnetic	10. Make a list of things magnets will stick to. Now make a list of things magnets will not stick to. What do the things on the first list have in common?
11. Recognizing that magnets are strongest at their ends or poles, and that the two poles of a bar magnet are labeled north and south	11. Where is a bar magnet strongest?
12. Recognizing that when two north poles are pushed together, they repel, as do two south poles, but when two different poles are brought close together, they attract	12. What happens when you push the two north poles of a magnet together? What happens when you push the two south poles together? What happens when you push a north and a south pole together?
13. Describing a compass as a small magnet balanced on a pivot which can be used to tell the direction of the north pole	13. How does a compass work? What can you find out from a compass?
14. Describing how to turn a piece of iron into a magnet (stroking the iron with a magnet)	14. How would you go about turning a piece of iron into a magnet?

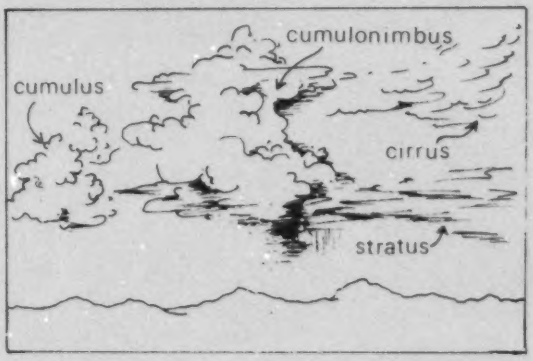
THIRD GRADE F

Mechanics 15. Identifying everyday uses of the six simple mechanical devices (lever, wheel and axle, inclined plane, pulley, wedge, and screw)	15. Give some examples of how each of these is used around the city of Boston: a. levers b. wheels and axles c. inclined planes d. pulleys e. wedges f. screws
16. Recognizing that work must be done to overcome friction, and naming some ways of overcoming (and also increasing) friction	16. What is needed to overcome the friction of a box being pulled along the floor? How could the job be made easier? What are some ways that people reduce the friction in cars, bicycles, trains, etc.?
17. Naming two forces at work on a cart rolling down a hill: gravity and friction	17. When a bicycle or cart is rolling down a hill, what two forces are acting on it? Make a drawing and show the forces as arrows.
Sound 18. Recognizing that all sounds are made by vibrations; they are transmitted through the air in all directions from their source	18. What causes the sound of notes played on a piano? The human voice? A truck's engine? A jet airliner? When something makes a sound, does the noise travel in one direction or in all directions?
19. Recognizing that sound can go through many solid objects; and are detected by our ears when they make our eardrums vibrate	19. Can sound travel through a solid object like glass or wood? How do our ears pick up sounds?
20. Describing sounds in terms of their relative loudness and pitch	20. Tell whether each of these sounds is loud or soft. Now tell whether each one is high-pitched or low-pitched. -a drag racing car -a flute -a trombone -a violin -a girl's voice -a man's voice

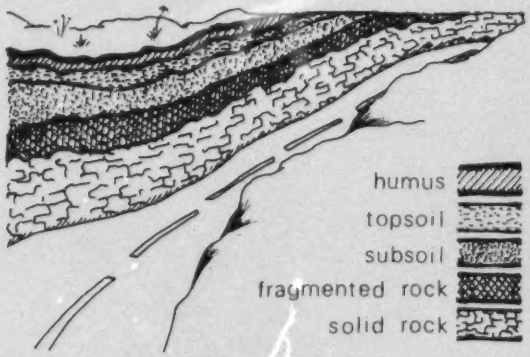
THIRD GRADE F, G

(21.) Describing how to make a higher- or lower-pitched sound: -tapping on a glass with water in it -blowing across the top of a bottle with water in it -plucking on a guitar string [maintained]	21. If you were blowing across the top of a bottle with water in it, how could you make the sound lower-pitched? How could you make it higher-pitched?
G. EARTH SCIENCE **Weather** (1.) Recognizing that when air is heated, it expands and rises, and that when it is cooled, it contracts and sinks	1. What happens to air when it gets hotter? What happens when air is cooled down? Describe an experiment to show your answers are correct.
2. Describing how the sun's rays shining on a dark plowed field or rooftop heats the surface, which heats the air above it, which makes the air rise upward as an updraft	2. Which of these would have the strongest updraft (or thermal) on a sunny day? -a field of golden, ripe wheat -a newly-plowed field -a swimming pool -a field with light, baked soil -a desert with golden sand -a dark green tennis court
3. Identifying uneven heating of different parts of the Earth's surface as the reason for local winds (as the heated air rises, cooler air blows in to fill up the space)	3. What causes wind to blow from one part of the countryside to another? Describe the process. Why does a breeze blow from the land to the ocean in the morning and from the ocean onto the land in the afternoon?
(4.) Explaining the stages of the water cycle: -water on the Earth's surface evaporates and rises upward as water vapor -the water vapor condenses into tiny droplets in the cooler temperatures above the Earth's surface, forming clouds -under certain temperature conditions, the droplets in clouds form into larger drops of water and fall to the Earth as rain (or snow, sleet, etc.) -the rain runs into rivers, lakes, and oceans, and some of it evaporates, repeating the cycle	4. Tell about the water cycle (the movement of water from the ground to the clouds and back again)

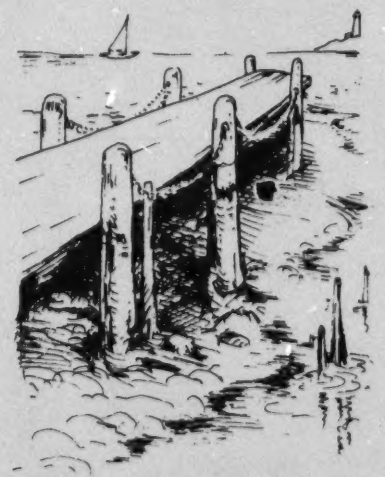
THIRD GRADE G

5. Recognizing and naming four types of clouds (cumulus, stratus, cirrus, and nimbus), and describing the kind of weather with which each is associated	5. Name the four most common types of clouds. What kind of weather does each kind usually bring? 
6. Identifying some extreme forms of weather and their characteristics (e.g., hurricanes, tornadoes, blizzards, etc.)	6. Describe some especially violent and dangerous kinds of weather.
7. Describing three basic instruments of weather observation, and the information each one gives (wind vane to tell the direction from which the wind is coming, anemometer to tell the wind's speed; thermometer to tell the temperature of the air)	7. Tell how each of these weather instruments work, and what information it gives us: a. wind vane b. anemometer c. thermometer
Geology 8. Identifying earthquakes, volcano eruptions, and slower movements of the Earth's surface as ways that new mountains are formed	8. How were mountains formed?
9. Describing ways that mountains and hills are constantly being worn down (windblown sand scouring; rainwater and rivers wearing them away)	9. Why do some mountains look sharp and jagged, while others are more rounded-off?
10. Classifying rocks by their major properties - texture, color, hardness, etc.	10. Give an example of a kind of rock that fits into each category: -hard or soft and crumbly -light-colored or dark-colored -heavy (dense) or light (less dense) <u>or</u> Teacher observation: Can students sort a collection of many different kinds of rocks into meaningful categories?

THIRD GRADE G, H

(11.) Recognizing that rounded stones and pebbles were originally sharp and jagged, but were worn smooth by water and wind	11. Were smooth, rounded stones always shaped that way? If not, what made them smooth and rounded?
(12.) Describing the way that rocks are constantly being broken up into sand and dirt (freezing, plants' roots, earthquakes, etc.) and mixed with organic matter to form soil	12. Where do the particles in sand and dirt originally come from? How did they get into the form they are in now?
13. Recognizing that soil is a relatively thin layer of mineral and organic matter covering the rocky mantle of the Earth	13. When bulldozers slice through a hillside to make way for a road, what layers are revealed? 
14. Describing the destructive effects of topsoil erosion on certain areas, and ways that erosion can be countered by planting trees, grass, etc.	14. What does the erosion of topsoil do that is so undesirable? How can it be stopped?
Prehistoric Life 15. Describing the characteristics of the major dinosaurs, and some possible reasons they became extinct	15. Choose a few of your favorite dinosaurs and describe what they looked like, using drawings if you like. Why do you think all the dinosaurs died out?
H. ASTRONOMY (1.) Recognizing how distance affects the apparent size of stars and planets, i.e., the sun is really much bigger than the Earth, but seems smaller because it is so many millions of miles away; some stars are really much bigger than the sun, but look tiny because they are so much further away from us than the sun	1. Which is bigger, the sun or the Earth? How do you explain the fact that the sun looks smaller than the Earth? Is the sun really bigger than the other stars we see in the sky? Why does it look so much bigger?

THIRD GRADE H

(2.) Making a schematic drawing of the solar system showing the sun in the center and the nine planets in nearly circular orbits around the sun, and labeling the Earth as the third planet out from the sun	2. Sketch the solar system, showing the sun and the nine planets and their orbits. Label the sun and the Earth.
(3.) Recognizing that there could be other undiscovered planets in our solar system beyond the nine that we already know about	3. Do scientists know for sure that there are only nine planets in our solar system?
(4.) Recognizing that the moon and other planets shine only with sunlight reflected from their surfaces	4. Where does the light of the moon and the nine planets come from?
(5.) Distinguishing between the rotation of the Earth on its axis (which takes 24 hours and causes night and day) and the orbit of the Earth around the sun (which takes 365 days and causes the seasons)	5. The Earth spins on its axis <u>and</u> moves in an orbit around the sun. Which movement takes 365 days and is responsible for our changing seasons? Which movement takes 24 hours and is responsible for night and day?
(6.) Recognizing that the moon orbits the Earth every 25 hours, repeating the same cycle every 28 days, always keeping the same face toward the Earth [Note: the exact time of the moon's orbit is 24 hours 50 minutes]	6. How long does it take the moon to orbit the Earth? How often does the moon's cycle repeat itself? Do we see all sides of the moon as it moves around the Earth?
7. Recognizing that the moon's gravitational pull affects the Earth's oceans (tides)	7. What affect does the moon's gravity have on the Earth? How would things be different if there were no moon orbiting the Earth? 

THIRD GRADE H, I

(8.) Describing the environment that astronauts encountered on the moon (no air, water, or life; very cold temperatures and very intense radiation from the sun; much less gravity)	8. Pretend you have just returned from a trip to the moon. Tell what you saw, and what you needed to stay alive there.
(9.) Describing how we can tell direction from the relative position of the sun (it is toward the east in the morning and the west in the afternoon) and the stars (the pole star is to the north)	9. How can you tell the direction of north, south, east, and west on a clear night? How can you tell directions during the day?
I. SCIENCE READING	
(1.) Reading at least three of the following science books or magazines, either as a part of the individual project (objective A-2), or as a separate activity	1. Teacher observation and record-keeping

SECOND AND THIRD GRADE SCIENCE BOOKS

Adkins	Heavy Equipment
Adler	The Calendar
	Calculator Fun
Adrian	Secret Neighbors: Wildlife in a City Lot
Aliki	Digging Up Dinosaurs
Allen	Everyday Wildflowers
	Everyday Turtles, Toads and Their Kin
Ames and Wyler	Prove It
Anderson	Junior Science Book on Sound
Anderson	Smallest Life Around Us
Atwood	The Kingdom and the Forest
Balestrino	The Skeleton Inside You
Bancroft	Animals in Winter
Barber	My Learn to Sew Book
Bare	Ground Squirrels
Baylor	Before You Came This Way

THIRD GRADE I

	Desert Is Theirs
Bendick	Exploring an Ocean Tide Pool
Berger	Energy From the Sun
	Jigsaw Continents
Billings	Salamanders
Blassingame	Skunks
Bonners	A Penguin Year
	Panda
Brady	Wild Babies: A Canyon Sketchbook
	Wild Mouse
Branley	Sky Is Full of Stars
	Eclipse, Darkness in Daytime
	The Sun Out Nearest Star
	What Makes Day and Night?
Brenner	Bodies
Bronson	Coyotes
Budlong	Experiments With Seeds and Plants
Bulla	What Makes a Shadow?
	A Tree Is a Plant
Burton	Life Story
Busch	Cactus in the Desert
Carrick	Crocodiles Still Wait
Charlip	Hand Talk
Cheney	Wolfie
Cobb	Fuzz Does It!
	Lot of Rot
Cole	Fish Hatches
	My Puppy Is Born
	A Snake's Body
	A Cat's Body
Cole and Wexler	Chick Hatches
Conklin	I Caught a Lizard
	Elephants of Africa
	Little Apes
	Lion Family
Cooke	Giraffes at Home

THIRD GRADE I

Corbett	What Makes a Plane Fly?
	What Makes a Car Go?
Cosgrove	Bone for Bone
Craig	Dinosaurs and More Dinosaurs
	Little Monsters
Crosby	Tarantulas: Biggest Spiders
Darling	Worms
	Turtles
Davidson	Nine True Dolphin Stories
Davis	Biography of a Fish Hawk
Dean	How Animals Communicate
Deguine	Emperor Penguin: Bird of the Antarctic
Demuth	City Horse
De Paola	Cloud-Book
De Regniers	The Shadow Book
Duvoisin	See What I Am
Earle	Camels and Llamas
Ennion and Tinbergen	Tracks
Fields	Sun
	Star and Planets
	Insects
Floethe	Fishing Around the World
Freedman	Animal Superstars: Biggest, Strongest, Fastest
	Farm Babies
	Getting Born [animals]
Freedman	Hanging On: How Animals Carry Their Young
Freeman	Blimps: On the Move
	Story of Electricity
Freschet	Owl and the Prairie Dog
Friedman	The Eel's Strange Journey
Froman	Mushrooms and Molds
Galdone	How Many Teeth?
	Look at Your Eyes
	Your Skin and Mine
Gans	Icebergs
	Birds Eat and Eat and Eat

THIRD GRADE I

	Hummingbirds in the Garden
	It's Nesting Time
	Millions and Millions of Crystals
Gardner	Magic Through Science
Garelick	What Makes a Bird a Bird?
	About Owls
Geis	Dinosaurs and Other Prehistoric Animals
Gemming	Born in a Barn
George	All Upon a Sidewalk
	All Upon a Stone
Giambarba	Surfmen and Lifesavers
Gibbons	Trucks
	Clocks and How They Go
Goldin	Straight Hair, Curly Hair
	Bottom of the Sea
	Sunlit Sea
	Spider Silk
	Ducks Don't Get Wet
Goldreich	What Can She Be? A Veterinarian
Goor, Ron and Nancy	Shadows: Here, There and Everywhere
Goudey	Houses From the Sea
Greene	Truck Drivers: What Do They Do?
	Animal Doctors: What Do They Do?
Gross	What Is That Alligator Saying?
Harris	Creatures with Pockets
	Crocodiles and Alligators
	Boats and Ships
	Helicopters
Hawes	Bees & Beelines
	Lady Bug, Lady Bug Flyaway Home
	What I Like About Toads
	Why Frogs Are Wet
Hellman	Lever and the Pulley
Henrie	Dogs
	Cats
Henry	Birds at Home

THIRD GRADE I

Hess	Listen to Your Kitten Purr
Hewett	Watching Them Grow: Inside a Zoo Nursery
Hirschman	In a Lick of a Flick of a Tongue
Hiss	Giant Panda Book
Hobbs	Cars
Hoffmeister	Zoo Animals
Hopf	Biography of a Snowy Owl
Hornblow	Animals Do the Strangest Things
Huntington	Let's Look at Reptiles
Hurd	Starfish
	Mother Deer
	The Mother Owl
Hutchings	Things That Go Word Book
	Saga of Pelrus Jack
Hutchins	Look at Ants
Iritani	I Know an Animal Doctor
Isenbart	A Duckling Is Born
Jacobs	Supersaurus
Jaspersohn	How the Forest Grew
Johnsen, Jan	Gardening Without Soil
Johnson, Hannah	From Seed to Jack-O'-Lantern
Jordan	How a Seed Grows
	Seeds by Wind and Water
Kaufmann	Little Dinosaurs and Early Birds
	Bats in the Dark
Keen	Be a Rockhound
Kehoe	The Puzzle of Books
Kettlekamp	Shadows
Knight	Those Mysterious UFO's
Kohn	The Beachcomber's Book
Kuskin	Space Story
Langseth	Apollo Moon Rocks
Larsson and Pudstrom	A Farm
Lasky	Tugboats Never Sleep
	The Weaver's Gift
Lauber	Seeds: Pop, Stick, Glide

THIRD GRADE I

	What's Hatching Out of That Egg?
Leach	The Lion Sneezed: Folktales and Myths
Lerner	Seasons of the Tallgrass Prairie
Littledale	The Magic Plum Tree
Loss	What Is It? A Book of Photographic Puzzlers
Lubell	Birds in the Street
Mandry	How to Grow a Jelly Glass Farm
Mari	The Apple and the Moth
	The Chicken and the Egg
Massie	Chameleon Was a Spy
May	Why People Are Different Colors
	Why Plants Are Green Instead of Pink
	Wildlife in the City
	Why the Earth Quakes
McCloy	Dogs at Work
McClung	Ladybug
McGovern	Little Whale
McGowen	Album of Dinosaurs
	Album of Whales
	Album of Prehistoric Animals
McMillan	Finest Kind O'Day: Lobstering in Maine
	Apples, How They Grow
McNulty	How to Dig a Hole to the Other Side of the World
Mendoza	Shadowplay
Meyers	Pearson, A Harbor Seal Pup
Michel	The Story of Nim: The Chimp Who Learned Language
Miles	Save the Earth
	Wharf Rat
Milgrom	Adventures With a Cardboard Tube
	Paper Science
Miller	Lambing Time
Milton	Here Comes the Robots
Mizamura	Emperor Penquins
Mizamura	The Blue Whale
Moche	Star Wars Question and Answer Book About Space
Moore	Seabury Cook Book for Boys and Girls

THIRD GRADE I

Morgenstern	Metric Puzzles, Tricks and Games
Morris	Big Cats
	Seahorse
Munari	From Afar It Is an Island
Myrick	Ants Are Fun
Nussbaum	Plants Do Amazing Things
Oliver	What We Find When We Look at Maps
Ommaney	Frogs, Toads and Newts
Parish	Dinosaur Time
Parker	Terrariums
Paul	Candies, Cookies, Cake
	Kids Cooking: A First Cookbook for Children
	Kids Gardening: A First Indoor Gardening Book
	Kids Outdoor Gardening
	Simple Sewing
Penny	The Penguins Are Coming
Peterson	How to Write Codes and Secret Messages
	Birds
Pfadt	Grasshoppers
Pfloog	Wild Animals and Their Babies
Pluckrose	Small World Series
Podendorf	True Book of Rocks and Minerals
Pringle	Cockroaches: Here, There and Everywhere
	Death Is Natural
Rabinowich	Horses and Foals
	Loch Ness Monster
Rahn	How Plants Are Pollinated
Rand, McNally	The International Atlas
Reiss	Colors
Reuter	My Mother Is Blind
Rich	Earth Movers
	Diesel Trucks
Riedman	Spiders
Robbins	Trucks of Every Sort
Rockwell	Toad
Rublowsky	Nature in the City

THIRD GRADE I

Russell	Winter: A Field Trip Guide
Sarnoff	Great Aquarium Book
	The Code and Cipher Book
Sattler	Dinosaurs of North America
Scheffer	Little Calf
Schlein	What's Wrong With Being a Skunk?
	Lucky Porcupine!
Schwartz	Magnify and Find Out Why
	Through the Magnifiying Glass
	When Water Animals Are Babies
	The Cat's Elbow and Other Secret Languages
Scott	Book of the Pig
Selsam	Sea Monsters of Long Ago
	Popcorn
Sharp	Simple Machines and How They Work
Shaw	Octopus
	Alligator
Shay	What Happens at the Zoo
Showers	Find Out by Touching
	Hear Your Heart
	How You Talk
	Look at Your Eyes
	Use Your Brain
	What Happens to a Hamburger?
	Me and My Family Tree
	No Measles, No Mumps for Me
	Sleep Is for Everyone
Shuttlesworth	ABC of Buses
	Dodos and Dinosaurs
Simon	Discovering Earthworms
	Mirror Magic
	The Long View into Space
	Exploring Fields and Lots
	Animals in Your Neighborhood
	The Optical Illusion Book
Smith	Play With the Wind

THIRD GRADE I

Sommer	Sidewalk Fossils
Spier	Noah's Ark
	Gobble, Growl, Grunt
Stein	How to Raise a Puppy
	How to Raise Mice, Rats, Hamsters, and Gerbils: A Child's Book of Pet Care
	How to Raise Goldfish and Guppies
Sterling	Fall Is Here
Stevens	Birth of Sunset's Kittens
Sullivan	Plants to Grow Indoors
Symonds	Tree Identification Book
Teleki	Goblin: A Wild Chimpanzee
Thurman and David	The Magic Lantern: How Movies Got To Move
Tinney	What Does the Tide Do?
Van Soelen	Cricket in the Grass
Walter	Make a Bigger Puddle, Make a Smaller Worm
Walther	A Spider Might
Webber	Bits That Grow Bit
	Up Above and Down Below
Welch	Sunflower!
Wexler	Secrets of the Venus's-Flytrap
Wise	Monsters of the Ancient Seas
Wolf	Anna's Silent World
Yolen	World on a String
Zaffo	Airplanes and Trucks and Trains
	Big Books of Real Building and Wrecking Machines
	Giant Book of Things in Space
Zaslavsky	Count on Your Fingers African Style
Zim	Waves
	Goldfish
	What's Inside of Plants
	Crabs
	Frogs and Toads
	Snakes
	The Universe
	Comets

THIRD GRADE I

Zim, ed.	Golden Field Guides:
	Birds
	Insects
	Mammals
	Reptiles and Amphibians
	Zoology
Zubrowski	Messing Around With Water Pumps and Siphons
	Messing Around With Straw Construction

MAGAZINES

Animals	Ranger Rick's Nature Magazine
National Geographic World	Scienceland
Odyssey	

FOURTH GRADE

A. SCIENCE EXPERIENCES

(1.) Carrying out and reporting on at least one hands-on science experiment or project, working individually or in a small group. The topics of the experience should be chosen by each student, drawing on the content for this grade level (see sections C - H) or other topics of interest to students. The experience is open-ended in terms of content, but should incorporate as many of the following general science processes as possible: a. Stating what you want to find out in clear and precise terms b. Planning the project or experiment, deciding what equipment and materials are needed, and gathering them c. Stating a hunch about what the result of the experiment might be d. Carrying out the experiment or project e. Observing and describing what happened, using measurement instruments to get precise readings if necessary f. Keeping records of data gathered in the form of notes, drawings, narrative, etc. g. Sorting, comparing, and classifying the information gathered, looking for patterns and regularities, similarities and differences h. Thinking about the data you gathered, and reaching some logical conclusions i. Presenting the conclusions in oral, written, or graphic form	1. Teacher observation: By the end of the year, has the student completed and reported on at least one direct science experience which includes most of the science processes. Some possible experiences: - observing daily changes in the growth of a plant - observing the behavior of an animal - collecting data on weather and/or seasonal changes - recording changes in the sun's shadows over the course of two or more weeks - recording one's own growth or the growth of other children - constructing an aquarium and/or terrarium to show the interdependence of plants and animals
(2.) Using books (see section I), interviewing, field trips, or other experiences to find out a great deal about at least one topic, and presenting a written report on that topic	2. Teacher observation: Has the student chosen a topic, made a thorough investigation of it, and presented a report? Some possible topics: - rocketry: history, models, etc. - flight: heavier-than-air craft - nuclear reactors - nuclear bombs - kinds of stars - plastics and their uses - making violins, guitars, etc.

FOURTH GRADE B

B. SCIENCE SKILLS AND PROCESSES	
Observing	1-11 These skills and processes should be applied in the Science Experiences, Life Science, Human Biology and Health, Physical Science, Earth Science, and Astronomy sections. Specific right-hand column examples are not given in order to encourage the application of the skills to all content areas. The substantial overlap of these skills with those in the mathematics curriculum document makes it possible to teach many science and mathematics skills simultaneously.
1. Observing carefully; noticing such details as size, shape, color, texture, weight, taste, smell, position, time taken, etc. (using a magnifying glass or elementary microscope when necessary)	
2. Recognizing that different people looking at the same thing can sometimes see it differently, and identifying ways to make objective observations	
Measuring	
3. Identifying the appropriate measuring instrument and unit of measurement for a task [Correlation with Math objectives]	
4. Measuring objects or lengths to the nearest quarter inch or to the nearest millimeter [Correlation with Math objectives]	
5. Measuring weight in ounces and pounds [Correlation with Math objectives]	
6. Measuring time to the nearest second [Correlation with Math objectives]	
7. Measuring temperature in degrees Fahrenheit [Correlation with Math objectives]	
8. Measuring volume in ounces, cups, pints, quarts, and gallons [Correlation with Math objectives]	
9. Making estimates of length, weight, temperature, and time when appropriate [Correlation with Math objectives]	

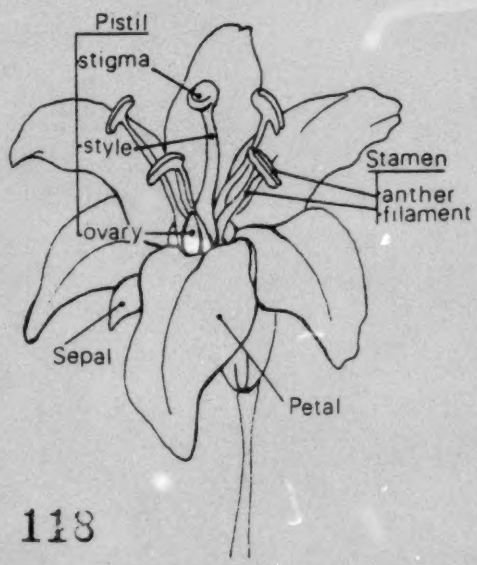
FOURTH GRADE B, C

Classifying 10. Organizing and categorizing objects and information in groups or in sequence according to certain criteria (e.g., kinds of animal, animals by habitat, etc.) (see content areas)	
Recording 11. Recording information in the form of sketches, picture or bar graphs, or other means, and interpreting pictures and graphs made by others [Correlation with Math objectives]	
Using Equipment 12. Using and maintaining science tools, and identifying safety hazards of some equipment	12. What are some tools that can injure people? How do such injuries occur?
Scientific Method 13. Distinguishing between an observation (which is purely descriptive) and an inference (which involves drawing conclusions from what you have observed)	13. Which of these are observations? Which are inferences? a. The planet Earth orbits the sun. b. It rained last night; I can tell because the ground is wet. c. My wallet is gone; it was stolen. d. My shoes are worn out.
14. Relating at least one story of how a famous scientific discovery was made, describing the factors that contributed to its success (methodology, persistence, cooperation, skill, luck, etc.)	14. Teacher observation: Has the student reported on at least one discovery in some detail? The focus should be on reporting the human story behind the discovery, noting the process that scientists went through.
C. SCIENCE AND SOCIETY	
1. Distinguishing between science and technology; recognizing that the latter is the application of scientific work in everyday and commercial settings	1. Which of these are examples of <u>science</u> and which are examples of <u>technology</u>? a. designing a new computer b. studying what's inside cells c. designing a bridge d. looking at far-away stars e. building a nuclear bomb
2. Describing the impact of at least three major scientific/technological advances of the past (e.g., the conquest of disease, the invention of the microscope, etc.)	2. Name three important inventions that were made more than a hundred years ago, and tell what life today would be like without them.

FOURTH GRADE C

3. Describing the impact of at least three recent scientific/technological advances (e.g., computers, robotics, nuclear energy, etc.)	3. Name three important inventions of the last twenty or so years, and tell how each one has changed people's lives.
(4.) Identifying the sequence of some major scientific/technological advances (e.g., radio was developed before television; propeller planes preceded jet planes; etc.)	4. Number each group of important inventions in the order in which they were made: __television __radio __smoke signals __balloons __jets __propeller planes __the calculator __the slide rule __the wheel __cars __trains
(5.) Describing at least one current scientific or technological issue (examples from past years could include DNA research, Three Mile Island, the space shuttle, etc.)	5. Tell about an important science or technology story that has been reported in newspapers and television this year. What made the story important enough to be in the news?
(6.) Describing the major contributions and some biographical details about a few famous scientists, including women and minority group members	6. Tell a little about the life and work of at least three of these scientists: -Alexander Graham Bell -Archimedes -Benjamin Banneker -Elizabeth Blackwell -George Washington Carver -Nicholas Copernicus -Jacques Cousteau -Marie Curie -Charles E. Drew -Amelia Earhart -Thomas Edison -Michael Faraday -Henry Ford -Galilei Galileo -Charles Goddard -Jane Goodall -Johann Guterberg -William Harvey -Matthew Henson -Earnest E. Just -Louis Leakey -Mary Leakey -Guglielmo Marconi -Garrett Morgan -Thomas Morse

FOURTH GRADE C, D

	-Isaac Newton -Florence Nightingale -Louis Pasteur -Leonardo da Vinci -James Watt -Daniel Hale Williams -Granville Woods -Wright brothers
7. Identifying some science-related vocations and avocations	7. Name at least five hobbies and jobs that are related to science and technology.
D. LIFE SCIENCE	
(1.) Distinguishing between things that are living and non-living, and listing some of the traits of living things	1. How can you tell whether something is living or non-living? Make a list of what you would look for to decide.
Plants (2.) Grouping plants into major types and listing the characteristics of each group (seed- and non-seedbearing, flowering and non-flowering, etc.)	2. Arrange these plants into groups according to whether they are seed-bearing or non-seedbearing, flowering or non-flowering: -pine tree -algae -oak tree -lily -rose bush -fern -orange tree -rhododendron
(3.) Recognizing parts of a flower in a drawing, and describing the functions of each part	3. Label the parts of this flower. [picture presented without labels] 

FOURTH GRADE D

(4.) Recognizing that fruit develops from the flowers of plants	4. From what part of a flowering plant does the fruit develop?
(5.) Describing the way that green plants produce starch by taking in carbon dioxide, water, minerals, and sunlight	5. How do green plants make food for themselves? What do they need to do this? What is the food they produce called?
6. Identifying the conditions under which mold will form on food	6. How can you get mold to grow on bread? What conditions are just right for mold to grow?
(7.) Identifying the conditions that are necessary for a seed to grow (moisture, the right temperature range, not necessarily light)	7. What conditions are necessary for a seed to grow into a plant?
(8.) Naming the ways that seeds are spread around (falling to the ground, exploding and blowing in the wind, carried by water, carried by animals, planted by humans)	8. Name at least three ways that plant seeds are spread from one place to another.
(9.) Describing how new plants can be grown by using cuttings and layering rather than seeds	9. Tell how it is possible to grow a plant without ever planting a seed.
Animals (10.) Identifying some characteristics that all animals have in common	10. Think of a wide variety of animals, from jellyfish to elephants, from cockroaches to whales. What do <u>all</u> these animals have in common?
(11.) Classifying animals as vertebrates and invertebrates, and identifying the main characteristics of each	11. Arrange these animals in two groups, vertebrates and invertebrates. -frog -spider -gorilla -dolphin -crab -dog -deer -bee -lobster -ant Now write some characteristics of each group.

FOURTH GRADE D

(12.) Classifying animals according to the environment in which they live (e.g., a city park, trees, lakes, the ocean, etc.)	12. List some animals you might find in each of these places: -a coral reef -a meadow -under a large boulder -in deep water in the ocean -in the desert -in a freshwater lake -in a swamp
(13.) Identifying some adaptations advantageous to predators: keen sense of smell, sharp claws, hooked beak, speed, appropriate birth time, etc.	13. What body adaptations help predators (such as eagles, hawks, lions, sharks, etc.) catch their prey? Make a list from all the predators you know.
(14.) Describing the life cycle of an insect, fish, amphibian, bird, or mammal	14. Choose one animal with which you are familiar and describe the changes it goes through in its life cycle.
15. Describing the metamorphosis of an insect as it develops	15. Choose one insect you are familiar with, and describe the metamorphosis it goes through in its life cycle.
(16.) Identifying ways of telling the age of certain living things (e.g., the growth rings on trees, rings on shells and mollusks, antlers on deer)	16. How can you tell how long a tree has been alive (or how long it lived before it died)? How can you tell the age of a deer? Of mollusks and shells?
(17.) Describing migration, hibernation, and dormancy as survival responses to severe winters	17. Why do some animals migrate, hibernate, or become dormant?
(18.) Giving reasons why some animals live in large groups (ants, caribou, geese, fish, etc.)	18. Give an example of an animal that lives alone or only with its mate. Give an example of an animal that lives in a large group. What are the advantages of living in a large group? Which kind of animal is more likely to survive hard times and predators?
19. Identifying some hunters (carnivores), grazers (herbivores), and omnivores among common animals	19. Give a few examples of each kind of animal: -carnivore -herbivore

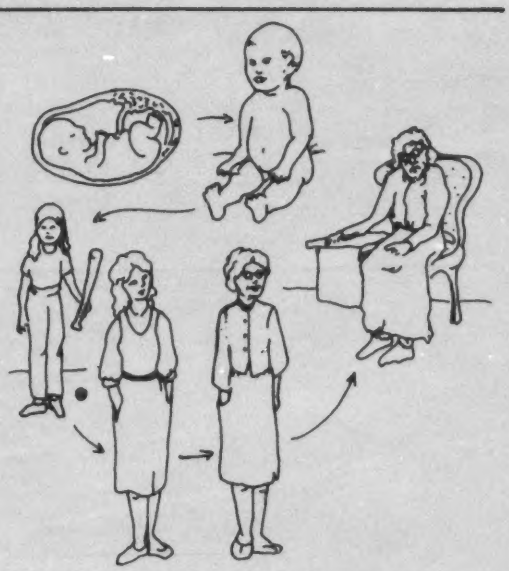
FOURTH GRADE D

(20.) Giving examples of the ways that humans use animals (companionship, entertainment, work, food), and exploring the moral issues involved in some of our uses of animals	20. List all the animals in the whole animal kingdom that help or are used by humans. In what ways do they help us? Do any of the ways that humans use animals trouble you? Why?
Ecosystems (21.) Describing interdependency of living things: -green plants use sunlight, water, and carbon dioxide to produce food and oxygen -small animals eat green plants and breathe oxygen -larger animals (predators) eat smaller animals (prey) and breathe oxygen -animals breathe out carbon dioxide and contribute nutrients to the soil when they die and decompose -plants absorb the carbon dioxide and nutrients	21. Tell about how plants need animals and animals need plants. Could they survive without each other?
(22.) Describing a simple food web (algae eaten by fish; fish eaten by humans)	22. What is a food web? Give a simple example.
23. Describing how some living things in a particular environment might be affected if one group were removed, or if humans intervened in some way (hunting, pollution, etc.)	23. Draw a diagram of a food web including herbivores, carnivores, both predators and prey. Draw lines to show how they are interdependent (need each other). Now assume one animal in the web is wiped out (perhaps by pollution). What will be the effect on the other animals?

FOURTH GRADE D, E

Evolution 24. Recognizing that each generation of plants and animals produces far more offspring than can possibly survive, and that the shortage of food, presence of predators, and other factors cause many of them to die	24. Do all the offspring of animals and plants survive and grow to maturity? What accounts for the death of many offspring? Why is it important for plants and animals to produce so many offspring?
25. Recognizing that there is great variety <u>within</u> each species of plant and animal (although offspring resemble their parents, each is slightly different)	25. Are all cows exactly alike? Are all roses exactly alike? Are all cats alike?
(26.) Explaining how extinction occurs in some species of plants and animals (their body adaptations no longer suit the changing environment)	26. Why do some plants and animals become extinct?
E. HUMAN BIOLOGY AND HEALTH	
(1.) Briefly describing the basic function of these bodily systems: digestive, circulatory, respiratory, skeletal, muscular, and nervous	1. What basic job does each of these systems do in our bodies? a. digestive b. circulatory c. respiratory d. nervous e. muscular f. skeletal
(2.) Tracing the route taken by a piece of food through your digestive system - chewed by the teeth, attacked by saliva, swallowed, mixed with digestive juices in the stomach, moved through the small intestine and absorbed through the walls, the residue eliminated	2. Pretend you are a French fried potato that has just been popped into a person's mouth. Write an account of what happens to you at each stage as you move through the person's digestive system. Where do the nutrients end up? What happens to the waste?
3. Identifying in sequence the stages of the human life cycle, and the major changes at each stage: fertilized egg, embryo, fetus, birth, infant, toddler, child, adolescent, adult, death	3. Starting with the fertilized egg, list the stages a person goes through in his or her life (there are about nine). What is the most important change at each stage?

FOURTH GRADE E

	
(4.) Distinguishing between inherited traits (e.g., hair color) and acquired traits e.g., large muscles developed by lifting weights)	4. Make a list of your traits that you inherited from your parents and ancestors. Now make a separate list of things you have developed or learned to do in your lifetime.
(5.) Distinguishing between instinctive behavior (e.g., eyes blinking) and learned behavior (e.g., reading and writing)	5. Which of these are <u>instincts</u>? Which are <u>learned</u>? -reading -ducking an object thrown at us -running from danger -riding a bicycle -writing -fighting to save our lives -using a computer -blinking when something moves quickly toward our eyes
(6.) Identifying food, water, light, air, exercise, rest, etc. as essential conditions for survival and growth	6. List all those things you know you must have to stay alive - nothing else! Now make a separate list of things you need to make life more enjoyable, interesting, and pleasant.

FOURTH GRADE E

Nutrition (7.) Giving examples of foods in each of the five food groups, and recognizing a balanced diet includes foods from the first four: -fresh fruits and vegetables -whole grain breads and cereals -dairy products -meat, eggs, nuts, beans, etc. -"junk foods" - candy, cookies, soft drinks, chips, etc.	7. Give at least three examples of foods from each of the five groups. What do people need to eat for a balanced diet?
8. Distinguishing between cellulose (undigestible portions of food necessary to the normal functioning of the digestive system) and "junk food"	8. The cellulose in lettuce, potatoes, and other foods passes straight through our digestive systems without giving us nutrition. Does this mean it is "junk food?"
Health (9.) Identifying some possible emotional and physical effects of lack of sleep	9. If you had no sleep for two entire nights, what would you feel like? Name some things you might do or not do. How would you act toward your family and friends?
10. Defining what sleep is - deep relaxation with the conscious mind "turned off" - and recognizing that people need different amounts of sleep at different points in their lives	10. What does sleep do for the human body? Does everyone need the same amount of sleep? Do you need as much sleep now as you did when you were a baby? Do grown-ups need as much sleep as children?
(11.) Recognizing that bacteria are all around us, and that some are helpful and others harmful	11. Where can bacteria (germs) be found? Give some examples. Where would you <u>not</u> find living bacteria? Are all bacteria harmful to people? How so?
(12.) Naming some ways disease germs can enter our bodies (by inhalation, swallowing, or through cuts in the skin)	12. How can disease germs get into our bodies? Name at least three ways. What is the most common way for us to catch colds from other people?
13. Identifying symptoms of common diseases and health problems (measles, pneumonia, cancer, stroke, heart attack, sickle cell anemia, Down's Syndrome, etc.) and their effect on the body	13. What are the symptoms of each of these? -the common cold -flu (influenza) -strep throat -measles -chicken pox -sickle cell anemia -Down's syndrome -stroke -heart attack -cancer -pneumonia

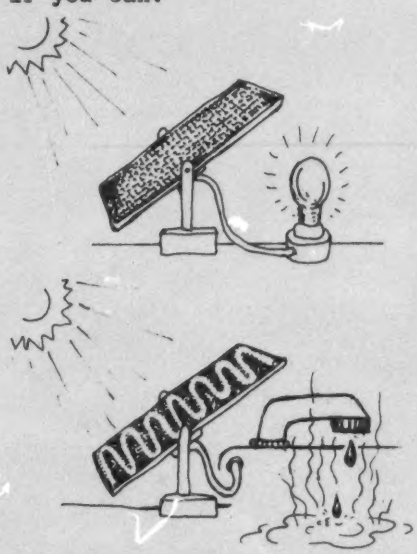
FOURTH GRADE E

(14.) Describing the effects of cigarette smoke on the human body, and the addictive power of nicotine	14. What affect does cigarette smoke have on the human body? Why do people who want to stop smoking find it so difficult to do so?
15. Describing the effect of a quantity of alcoholic beverages consumed in a short space of time, and identifying some major reasons for abusive drinking (the disease of alcoholism; attempts to escape emotional problems; peer pressure)	15. What affect does a quantity of alcohol (more than two or three drinks of beer, wine, or hard liquors) have on the human body? What are reasons that some people drink too much?
16. Differentiating between ailments that one can treat oneself, and those that require a doctor's care	16. Which of these would you be safe in treating yourself at home, and which should you definitely see a doctor about? -a broken bone -a serious cut on your forehead -a cold -the flu -cancer -a twisted ankle -sore muscles -a headache
(17.) Identifying temperatures over "normal" - 98.6 degrees Fahrenheit - as increasingly dangerous indications of disease (but realizing that there are individual differences in temperature range)	17. If your temperature is above 98.6 degrees, what does that tell you? What if it is above 103 degrees? Do all healthy people have a temperature of exactly 98.6 degrees?
(18.) Describing the steps in a doctor's routine checkup	18. What does a doctor look for when you go in for a routine checkup? What does he or she do?
(19.) Recognizing that shots (immunizations) mobilize antibodies which fight off particular disease germs	19. What do inoculations (shots) do to our bodies?
Safety (20.) Describing the recommended steps for escaping from a burning building: -leaving immediately -crawling to escape smoke -breathing through a wet handkerchief -using stairs, not elevators	20. If you are caught in a building with a fire, what should you do and <u>not</u> do?

FOURTH GRADE E, F

(21.) Identifying some major safety hazards for this age group, and describing ways of minimizing the risks of each: -pedestrian accidents -injuries in car accidents (seat belts) -bicycle accidents -fire (see above) -power tools (sewing machines, drills, saws, etc.) -toxic substances (asbestos, mercury, etc. -various eye injuries -swimming -sports, especially hockey and football	21. What are some ways that children your age are sometimes injured or killed? Tell how you can cut down your risk of being a victim of each.
F. PHYSICAL SCIENCE **Matter** (1.) Identifying the three states of matter (solid, liquid, and gas), and giving examples of each	1. What are the three forms that matter takes? Give a few examples of each.
(2.) Recognizing that all matter is made up of tiny building blocks (atoms)	2. What are the tiny building blocks of matter called?
(3.) Identifying the three different forms water can take (liquid, ice, and vapor), and the necessary conditions for water to change from one state to another	3. What three states of matter can water be found in? What has to happen for water to change from one state to another? Give an example.
(4.) Describing the process by which some substances dissolve in water (e.g., sugar in water), disappearing and spreading out evenly throughout the solution	4. What happens when something dissolves in water? Give an example.
(5.) Recognizing that the bubbles in boiling water come from water vapor created when the water boils	5. What are the bubbles that come out of boiling water? Where do they come from?

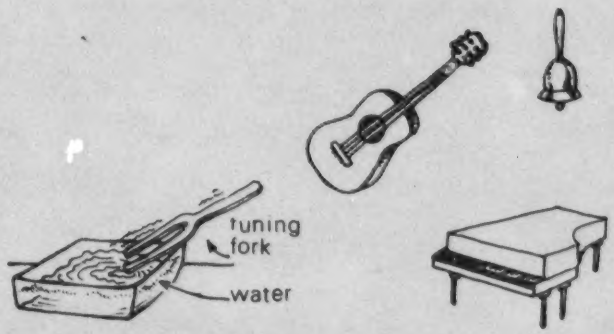
FOURTH GRADE F

Energy 6. Naming some sources of electrical energy (hydroelectric, diesel, nuclear, other generators)	6. What are some of the ways that electricity can be generated? Name at least three.
7. Giving examples of ways that one form of energy is converted into another (light to heat, as in solar panels; electricity to motion, as in an electric motor; motion to electricity, as in a hydroelectric dam)	7. Here are several forms of energy: light, heat, motion, electricity. Give some examples of how one form of energy is changed into another.
8. Tracing back the energy used in an everyday situation (e.g., a car is powered by gasoline; the gasoline was made from oil; the oil was formed from the decay of dead animals that lived millions of years ago; those animals ate plants and other animals that ate plants; the plants grew because of sunlight)	8. Show how each of these forms of energy originally came from the sun: a. electricity b. steam power c. rocket fuel power d. atomic power e. water power
9. Identifying some recently developed ways of trapping the sun's light energy and harnessing it (solar panels; photovoltaic cells; passive solar construction, etc.)	9. How can the sun's rays be used to heat a house or make electricity? Use drawings if you can. 
10. Describing the advantages and disadvantages of a primary source of energy (e.g., oil is convenient, but pollutes the air and is rapidly being depleted; solar energy is inexhaustible and non-polluting, but is expensive and difficult to harness)	10. Every kind of energy has advantages and disadvantages. List some of the pluses and minuses of each of these: a. solar power b. oil (made into gasoline, etc.) c. coal d. water power

FOURTH GRADE F

11. Describing three ways that the heat in a pot of boiling water can be lost (radiation, conduction, and convection)	11. If you take an uncovered pot of boiling water off the stove, it will cool down in a few hours. Where did the heat go? How was it lost? Name three ways.
Magnetism 12. Identifying objects to which magnets will stick, including nickel, cobalt, and metals containing iron	12. Which of these will a magnet stick to? -iron -cobalt -aluminum -bricks -plastic -nickel -wood -glass
13. Describing what the invisible magnetic field around a bar magnet looks like	13. Make a drawing to show what the magnetic field around a bar magnet looks like. How could you prove this to someone who didn't believe you?
14. Describing how to make an electromagnet by wrapping wire around a piece of iron and running electricity through the wire	14. If you had an iron nail, a battery, and a piece of wire, how could you make a magnet?
Electricity 15. Giving examples of static and current electricity (lightning, sparks from your body on a dry day; electricity from a battery or household plug)	15. Where can you find <u>current</u> electricity? Where can you find <u>static</u> electricity?
16. Distinguishing between good and poor conductors of electricity	16. Write whether each of these is a good or poor conductor of electricity -wood -rubber -copper -the human body -iron -aluminum -glass -plastic
17. Recognizing that electricity will only flow in a closed circuit involving a source of electrical power, and describing how to make a simple electric circuit out of a battery, bulb, and wire	17. If you have a battery, some wire, and a light bulb, how can you get the bulb to light up? Make a drawing to show how you would hook things up.

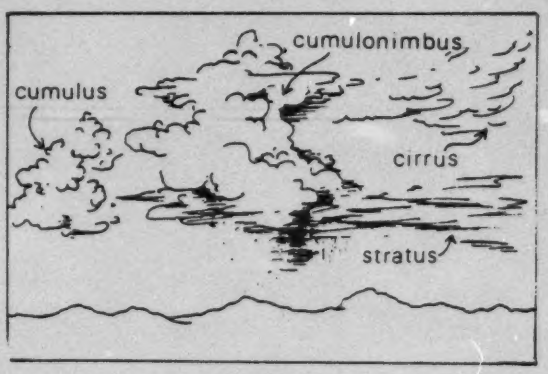
FOURTH GRADE F

Mechanics and Forces 18. Describing ways to use the six simple mechanical devices (levers, wheel and axle, pulleys, screw, inclined plane, and wedge)	18. Give an example of each of these in action. Can you think of machines that have more than one? a. levers b. wheels and axles c. pulleys d. inclined plane e. wedge f. screw
19. Identifying sliding friction as something that makes it difficult to slide one object over another, and giving examples of situations where friction is a problem (sliding a heavy box up a concrete ramp) and where it is helpful (a bicycle's brakes slowing you down on a hill)	19. What is sliding friction? Give an example of a situation where friction makes things more difficult. Give an example of an everyday use of friction that can save your life.
20. Identifying the use of lubrication and ball bearings as two ways of overcoming friction, and citing examples of places where they are used	20. What are some common ways of reducing friction? Where are they used?
(21.) Recognizing that the Earth's gravity pulls everything straight down toward the center of the planet, and relating the story of how Sir Isaac Newton first discovered this force	21. What does gravity do to your body and the objects around you? Tell about how Sir Isaac Newton realized how gravity worked.
22. Recognizing that the time each swing of a pendulum takes is determined by the length of the pendulum's arm	22. Which pendulum will take longer to swing back and forth: one with a one-foot string, or one with a three-foot string?
Sound (23.) Describing how sound is produced by various sources, identifying vibrations as the key factor in each case (e.g., our vocal cords vibrating; the strings of a violin vibrating, etc.)	23. How is sound made by a trumpet? A guitar? A bell? A piano? A tuning fork? Our vocal cords? A drum? 

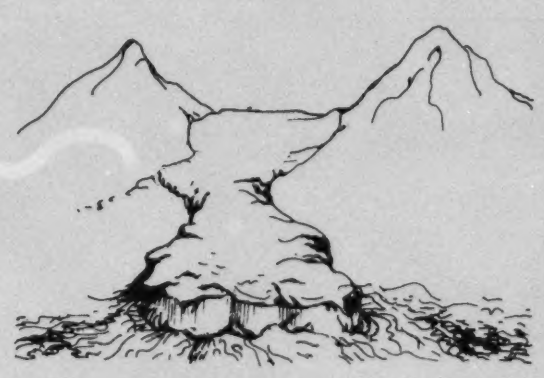
FOURTH GRADE F, G

24. Distinguishing between the loudness and the pitch of a sound, and describing the differences in sound waves that affect each	24. Give an example of a sound that is loud <u>and</u> low-pitched. Now give an example of a scund that is soft <u>and</u> high-pitched. How are the sound waves of high- and low-pitched sounds different?
25. Describing how high- and low-pitched sounds can be produced by various kinds of musical instruments (guitar, flute, drum, etc.)	25. Playing one string of a guitar, how can you make the note higher or lower? How can you make a a drum's sound higher?
<u>G. EARTH SCIENCE</u> **Weather** 1. Explaining how soaring birds can stay aloft and even move upward without flapping their wings (updrafts caused by heated air rising up through the atmosphere)	G. EARTH SCIENCE 1. What makes it possible for birds to stay aloft and get higher off the ground without moving a muscle?
(2.) Explaining how the sun's uneven warming of the Earth's surface (dark-colored areas absorbing more heat than light-colored areas; bodies of water taking longer to warm up and cool off than bodies of land) causes winds and other weather phenomena	2. What causes winds?

FOURTH GRADE G

(3.) Identifying tropical zones closest to the equator as the places where it is most likely that quantities of warm air will be rising up into the atmosphere; and explaining how this factor affects the weather in these and other areas	3. What part of the planet Earth has the greatest amounts of warm air rising up into the atmosphere? What affect does this have on the world's weather?
(4.) Identifying the three stages of the water cycle: evaporation; formation of clouds; and precipitation	4. What three stages does water go through as it passes through the water cycle?
(5.) Identifying different kinds of clouds (cirrus, cumulus, nimbus, and stratus), and naming the kind of weather with which each is associated	5. Name and describe at least three kinds of clouds (sketch them if possible), and tell the kind of weather each one usually brings. 
(6.) Describing how the weather in a given location is influenced by various factors: -proximity to the equator -prevailing winds -nearby oceans or lakes -mountains	6. What affects the kind of weather a particular city has? What are factors in the weather in Boston? In Denver? In San Francisco? In Miami? In Fairbanks?
7. Identifying the basic measurements that meteorologists take to describe the weather (temperature, wind speed, wind direction, humidity, barometric pressure), and what each piece of data tells them	7. Name the five most important measurements that a meteorologist (weather forecaster) makes. What does each one tell the forecaster?

FOURTH GRADE G

Geology 8. Recognizing that, over millions of years, the surface of the Earth has been constantly changing due to internal and external forces (volcanic eruptions, earthquakes, glaciers, erosion, etc.)	8. How has the surface of the Earth changed over the last three billion years? What forces have changed it?
9. Identifying some natural wonders caused by erosion (e.g., the Grand Canyon), and the destructive effects of topsoil erosion	9. How is erosion an enemy of farmers around the world? Name a natural wonder in the Western United States that is the product of erosion.
10. Describing some geological effects of the glaciers that once crept across New England	10. When the glaciers crept across New England thousands of years ago, what did they do to the land? 
11. Describing some effects that humans have had on the Earth's surface, both positive and negative	11. Name some ways that the Earth's surface would be different if humans had never lived on the planet. With every difference you write down, tell whether you think it is good or bad for the Earth.
12. Labeling a diagram of a cross section of the three layers of the Earth: crust, mantle, and core	12. Sketch a cross-section of the Earth, and label the crust, mantle, and core.
13. Describing how the three types of rock are formed, and giving an example of each: -igneous (such as granite); when magma or lava from a volcano cools -sedimentary (such as sandstone); when sand or other sediment is compressed in layers into rock over the years -metamorphic; when sedimentary rocks are hardened and squeezed into different rocks (such as limestone being changed to marble)	13. How is each type of rock formed? a. igneous b. sedimentary c. metamorphic

FOURTH GRADE G, H

14. Recognizing that minerals (such as quartz, feldspar, mica) are the basic types of matter in igneous and metamorphic rocks	14. What kinds of matter are rocks made of? Give some specific examples.
(15.) Describing the fossils which are found in certain rocks as indications of living things from long ago	15. What are fossils? What do they tell us?
(16.) Identifying geologists as scientists who study the history of the Earth and the rocks and minerals that make up the Earth's surface	16. Describe the work of geologists.
H. ASTRONOMY **The Solar System** (1.) Recognizing that the nine known planets vary in size and circle the sun at different distances, held in orbit by the sun's gravity, and that Earth is the third planet from the sun	1. Are all the planets the same size? Are they all the same distance from the sun? What holds all the planets from flying out into space? What is the Earth's position in the solar system?
(2.) Distinguishing the sun and other stars (which shine because they are balls of intensely hot gases) from the planets and other satellites (which shine by reflecting the sun's light from their surfaces)	2. What is the most important difference between a star and a planet?
(3.) Recognizing that early humans thought the Earth was flat, and describing some ways that humans figured out that they lived on a spherical planet (ships getting lower on the horizon as they sailed further out to sea; the curved shadow of the Earth on the moon during a lunar eclipse; measurements by the ancient Greeks of the angle of the sun at noon in different locations)	3. What did early humans think the shape of the Earth was? Tell how people figured out that the Earth was really spherical.

FOURTH GRADE H

(4.) Recognizing that until fairly recently, people thought the Earth was the center of the universe, with the sun and other planets revolving around it, and describing how upset some people were when Copernicus first put forward the theory that the Earth actually moves around the sun	4. Why did Copernicus's discovery that the Earth orbits around the sun upset people so much?
(5.) Describing the sun as an average-size star in the Milky Way galaxy, which has many millions of other stars	5. Compared to other stars, is our sun large, medium-sized, or small? What is the name of the galaxy in which our solar system is located? Roughly how many stars are there in this galaxy?
(6.) Identifying constellations as groups of stars that have a distinctive shapes (such as the Big Dipper, Orion, etc.), and sketching several of the constellations	6. What is a constellation? Can you draw two of them?
(7.) Describing how to locate the North Star on a clear night	7. If you were standing outside on a cloudless night, how would you know which star was the North Star?
8. Distinguishing between meteors, comets, and artificial satellites by their appearance in the sky	8. How can you tell a meteor from a comet from a human-made satellite? How do they look and move?

FOURTH GRADE H

The Moon (9.) Recognizing that the moon rises an hour earlier every day, and repeats its cycle every 28 days	9. How often does the moon rise (how many hours pass between each rising)? How many days pass before the moon repeats its cycle?
(10.) Recognizing that the phases of the moon are caused by the sun shining on the moon's surface from different angles	10. What causes the phases of the moon? Why is it full some days, less than full other days?
11. Recognizing that tides are caused by the gravitational pull of the moon and the sun overhead as the Earth rotates, exerting tractional force	11. What are tides? What causes them?
The Seasons (12.) Recognizing that in Boston, daylight hours get longer until June 21, and then shorter until December 21	12. What day of the year has the most daylight hours in Boston? What happens to the number of daylight hours after this day? What day of the year has the fewest number of daylight hours?
(13.) Observing that during the winter, the sun is lower in the Boston sky than it is in the summer	13. During which season is the sun lowest as it moves across the sky?
(14.) Recognizing that the reason the winter sun in Boston fails to give us warm weather is not because the sun is further away, but because it is shining at a lower angle than it does in the summer, and loses a lot of its heat in the atmosphere	14. Why does the sun here in Boston seem less warm in winter than it does in the summer?
15. Recognizing that the more air the sun's heat energy has to pass through before it reaches us, the more heat it loses, and the less heat energy reaches the Earth's surface	15. What affects the amount of the sun's heat that reaches us? Why does less reach us in the winter?
(16.) Using a schematic sketch of the Earth and sun to show how the sun shines most directly on the area near the equator, less directly on the areas just above and below the equator, and least directly of all on the north and south poles	16. Make a sketch to show which parts of the Earth get the most direct sunlight and which parts get the least.

FOURTH GRADE H, I

(17.) Identifying the tropical, temperate, and arctic zones on a rough map of the Earth, and relating them to the sketch used in the previous objective	17. Now label the tropical, temperate, and arctic zones on the map you sketched.
I. SCIENCE READING	I. SCIENCE READING
(1.) Reading at least three of the science books or magazines listed at the end of the fifth grade objectives, either as a part of the individual project (objective A-2), or as a separate activity	1. Teacher observation and record keeping

A. SCIENCE EXPERIENCES	
(1.) Carrying out and reporting on at least one hands-on science experiment or project, working individually or in small groups. The topics of the experience should be chosen by each student, drawing on the content for this grade level (see sections C - H) or other topics of interest to students. The experience is open-ended in terms of content, but should incorporate as many of the following general science processes as possible: a. Stating what you want to find out in clear and precise terms b. Planning the project or experiment, deciding on the equipment and materials needed and gathering them, and deciding whether a set of control observations is needed c. Stating a hypothesis (an educated guess) about what the result of the experiment might be d. Carrying out the experiment or project, manipulating the variables to discover pertinent information e. Observing and describing what happened, using measurement instruments to get precise readings where necessary; testing the hypothesis f. Keeping records of data gathered g. Sorting, comparing, and classifying the information gathered, looking for patterns and regularities, similarities and differences h. Thinking about the data gathered, and reaching some conclusions i. Presenting the conclusions in oral, written, or graphic form	1. Teacher observation: By the end of the year, has the student completed and reported on at least one direct science experience which includes most of the science processes? Some possible experiences: - observing the growth and changes in plants and animals - collecting systematic data on the weather - recording differences in the sun's position from shadows - constructing an aquarium or terrarium and using it to study the interaction of animals, plants, and their environment - using a trip to the Science Museum to gather data on a particular topic - air pollution studies - water pollution studies - food preservation studies
(2.) Using books (see section I), interviewing, field trips, or other experiences to find out a great deal about at least one topic, and presenting a written report on that topic	2. Teacher observation: Has the student chosen a topic, made a thorough investigation of it, and presented a written report? Some possible topics: -jet engine design -rockets: Apollo, space shuttle, etc. -space stations -life on other planets -U.F.O.'s - myth or reality -computers

FIFTH GRADE B

B. SCIENCE SKILLS AND PROCESSES

Observing

1. Observing carefully; noticing such details as size, shape, color, texture, weight, taste, smell, position, time taken, etc. (using a magnifying glass or elementary microscope when necessary)

2. Recognizing that different people looking at the same thing can have different observations, and identifying ways of making measurements more objectively

Measuring

3. Identifying the appropriate measuring instruments and units of measure for a task [Correlation with Math objectives]

4. Measuring length in English or metric units (inches or centimeters, etc.) [Correlation with Math objectives]

5. Measuring weight in English or metric units (pounds or kilograms, etc.) [Correlation with Math objectives]

6. Measuring time to the nearest second [Correlation with Math objectives]

7. Measuring temperature to the nearest degree in Fahrenheit or Celsius [Correlation with Math objectives]

8. Measuring volume in English or metric units (quarts or liters, etc.) [Correlation with Math objectives]

9. Making estimates of length, mass, temperature, time, or volume when approximate measurements are adequate [Correlation with Math objectives]

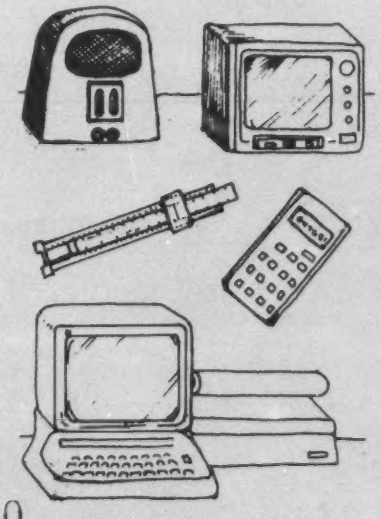
1-11

These skills and processes should be applied and assessed in the Science Experiences, Life Science, Human Biology and Health, Physical Science, Earth Science, and Astronomy sections. Specific right-hand column examples are not given in order to encourage the application of the skills to all content areas. The substantial overlap of these skills with those in the mathematics curriculum document makes it possible to teach many science and mathematics skills simultaneously.

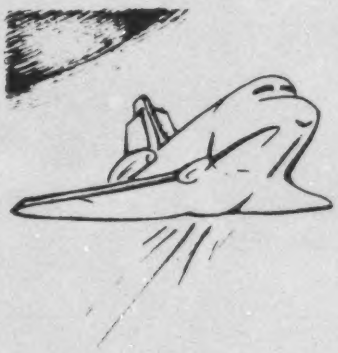
FIFTH GRADE B

Classifying 10. Organizing and classifying objects and information	
Recording 11. Recording information in the form of sketches, graphs (picture, bar, or line), and written accounts, and interpreting pictures, graphs, and accounts done by others [Correlation with Math objectives]	
Using Equipment 12. Using and maintaining a variety of science tools, and identifying the safety hazards of some items	12. Teacher observation: Can students work with, take proper care of, and avoid the dangers of scientific instruments and equipment?
Scientific Method 13. Distinguishing between observations and inferences in an experiment	13. Which of these are observations and which are inferences? -the sky is filled with clouds -it is about to rain -most of the clouds are cumulus -the barometric pressure is falling
14. Identifying the variables in an experiment	14. Carlos planted seeds in three pots. He put one pot in a sunny window, one in a window with no direct sun, and one in a warm closet, and watered them all every day for a week. What are the variables in this experiment?
15. Distinguishing between an observation and a prediction in an experiment	15. After a few days, Carlos noticed that the plant in the non-sunny window was growing more quickly than the other two. He said that the plant in that window was going to grow to be the tallest. -What was Carlos's observation? -What was his prediction?
16. Relating at least one story of how a famous scientific discovery was made, describing the factors that led to success (procedures, cooperation, persistence, luck, etc.)	16. Tell about how at least one important scientific discovery was made. How important was each of the following? luck, hard work, teamwork, courage, persistence

FIFTH GRADE B, C

17. Relating at least one story of scientific fraud and how it was uncovered	17. Tell about at least one scientific fraud - a situation where a scientist made up or falsified data and tricked people into believing it was accurate work. How was the fraud discovered? Here are some possibilities: -Piltdown man -Cuvier hoax -Leisenkovism -Midwife toad -Cardiff giant -Cyril Burt -William Darsee
C. SCIENCE AND SOCIETY	
1. Distinguishing between science and technology ("pure" versus "applied")	1. What is the difference between science and technology? Give some examples of work in each area.
2. Describing the impact of at least three scientific/technological advances on the development of the United States [this correlates with the Social Studies curriculum for this grade level] (e.g., the invention of the steam engine, the cotton gin, the railroads, etc.)	2. Tell about at least three discoveries or inventions that helped the development of the United States over the last 200 years.
(3.) Describing the impact of at least three recent scientific/technological advances (e.g., nuclear energy, the exploitation of solar energy, computers, robotics, etc.)	3. Tell about at least three inventions or discoveries made in the last 15 years. How have they changed people's lives? 

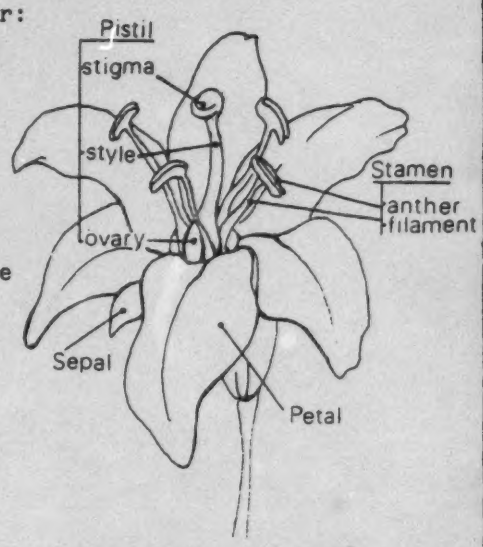
FIFTH GRADE C

(4.) Identifying the sequence of some major scientific/technological advances (e.g., the invention of anesthesia preceded major surgical advances; the invention of the rocket followed the development of the propeller plane)	4. Number each group of inventions or breakthroughs in the order in which they were made: __space rockets __propeller planes __jet planes __automobiles __heart transplants __the first anesthesia __X-rays __appendectomies
(5.) Describing at least one current scientific or technological issue from the current school year (examples from previous years would include acid rain, Three Mile Island, the space shuttle, etc.)	5. Tell about at least one science-related story that has been in the news this year. Why do you think it attracted so much attention? 
6. Describing at least one example of "non-science"; identifying the reasons scientists criticize such phenomena and the ways in which their proponents defend them	6. Choose one or more of the topics below (or others in the same category) and explain the claims made by proponents. How do scientists criticize these beliefs, and what is the response of proponents? -astrology -U.F.O.'s -parapsychology -psychokinesis -Bermuda Triangle -Atlantis -dowsing rods -pyramid power -tarot cards -E.S.P.

FIFTH GRADE C, D

(7.) Describing the most important contributions and some biographical details about a few major scientists, including women and minority group members	7. Teacher observation: Has the student prepared a brief report on at least five scientists, including details of their life and major work? The choice of scientists should cover men and women and members of minority groups. [This report can fulfill objective A-2; see Appendix for list.]
(8.) Identifying some science-related vocations and avocations (e.g., medicine, oceanography, aviation, engineering, zoology, science teaching, research) and describing the level of education and training required for each	8. What are some hobbies that involve science and technology? What are some jobs in the field of science and technology? What kind of schooling and background does a person have to have to get these jobs?
D. LIFE SCIENCE **Plants** (1.) Listing the functions that distinguish living organisms from things that are non-living	1. Name the ways you can tell a living from a non-living thing.
2. Describing the characteristics of some single-celled organisms, based on observation through a microscope	2. From what you have seen through a microscope or from pictures taken through a microscope, tell what a few single-celled organisms look like (for example, amoeba, flagellate). Make a sketch to illustrate.
3. Describing how and where some single-celled organisms live (e.g., pond water, puddles, refrigerator, the human body, etc.)	3. Name some places where single-celled organisms live. What do they need to survive?
(4.) Grouping plants into categories and listing the characteristics of each group and sub-group (e.g., vascular and non-vascular, seed-bearing and non-seedbearing, flowering and non-flowering, etc.)	4. List some plants in each of these categories: -vascular and non-vascular -seedbearing and non-seedbearing -flowering and non-flowering What are some important characteristics of each group?
5. Describing the differences in the life cycles of annual, biennial, and perennial plants	5. How long does each of these kinds of plants live? -annuals -biennials -perennials

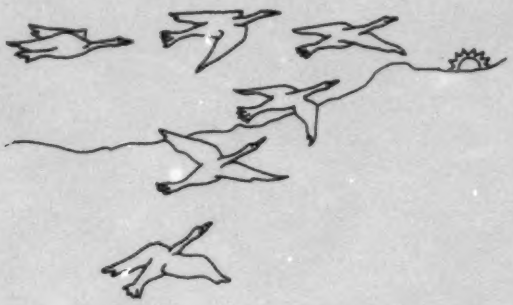
FIFTH GRADE D

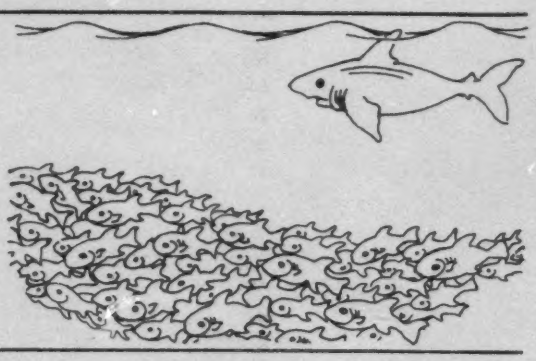
(6.) Recognizing the various parts of a flower (a real flower or a drawing or diagram) and the function of each	6. Point out or label each of these parts of a flower: -style -stigma -pistil -anther -stamen -filament -petal -sepal -receptacle -ovary  [picture would be presented unlabeled]
(7.) Recognizing that sunlight, carbon dioxide, water, and chlorophyll interact in the process of photosynthesis to produce starch (glucose)	7. Tell how plants make the food they need to survive and grow. What is this process called?
8. Describing the way in which non-flowering plants reproduce (pollen and egg, fertilization, embryo, (spore-producing plants) spore, germination with half male and half female, plants, pollen and egg, etc.	8. Tell how non-flowering plants (such as fern or moss) produce the next generation.
(9.) Identifying the basic conditions for, and the stages of, seed germination	9. What conditions must a seed have to germinate? What must a seedling have to continue to grow and survive? What stages do germinating seeds go through?
Animals (10.) Identifying the similar life functions of many animals: movement, getting food, digesting food, taking in oxygen, protecting themselves, and reproducing	10. What are some things that all animals have to do to survive? Make a list.

FIFTH GRADE D

(11.) Classifying animals as vertebrates and invertebrates, and dividing vertebrates into five categories: fish, amphibians, reptiles, birds, and mammals	11. Think of as many animals as you can (use a reference book to help out). Which are invertebrates? Which are vertebrates? Which are fish, amphibians, reptiles, birds, mammals?
(12.) Identifying adaptations in a given animal's body, and describing how they help it survive (e.g., webbed feet, keen eyesight, massive teeth, etc.)	12. Choose one animal and examine its adaptations. How do its adaptations help it survive? Are there any parts of the animal's body that don't help it survive?
13. Comparing and contrasting the ability of warm-blooded and cold-blooded animals to survive in different climates	13. In what climates can cold-blooded animals survive? How about warm-blooded animals? Give some examples What is the most important difference in the way their bodies work?
14. Describing the way fish breathe by obtaining dissolved oxygen out of the water around them through their gills	14. How do fish get oxygen under water?
15. Naming the sequential stages in the life cycle of a common animal	15. Describe the life cycle (from egg to adult) of each of these animals: -frogs -fish -chicken -dogs
16. Describing the phenomenon of regeneration, by which some animals can grow new body parts to replace those that have been lost	16. When animals like starfish, lizards, crayfish, salamanders, and others lose a limb, what happens? Can humans do the same thing?
(17.) Describing various kinds of animal and plant behavior: -migration, which helps animals find food, especially in harsh winters -hibernation, which helps animals survive harsh winters with virtually no food -living in large groups, which helps animals protect one another from predators -territoriality, which allows animals to restrict an area for their own use -pecking orders, which reduce stress in a population	17. Tell about each of these patterns of behavior among animals, giving the most important reasons for each one: -migration -hibernation -living in large groups -territoriality -pecking orders

FIFTH GRADE D





18. Describing different degrees of parental care of young among animals (ranging from none among most reptiles to extensive nurturing over a period of years among primates and some mammals)

18. Tell about how some different animals do and do not care for their young. You might compare a whale, a chimpanzee, a robin, a tree toad, a catfish, a lizard, and a shark.

19. Giving examples of ways that humans use animals (companionship, for entertainment, for work, for food), and exploring some of the moral issues of some of our uses of animals

19. Make a list of ways that humans use different kinds of animals. Are there any uses of animals that bother you? Explain why.

Cells

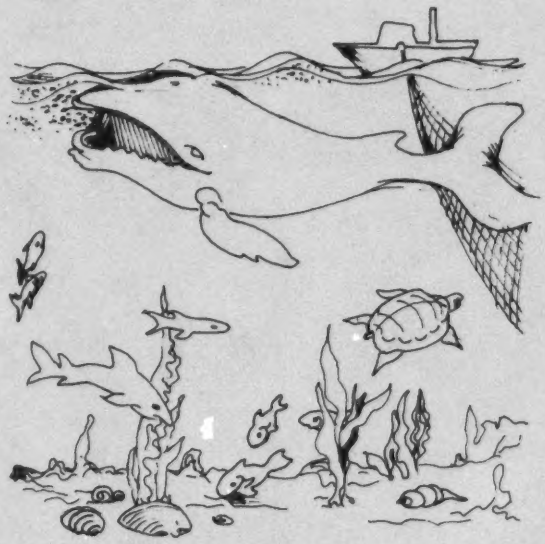
(20.) Recognizing that the cell is the basic unit of all living things

20. What is the basic living unit of all plants, animals, and protista?

(21.) Knowing that the smallest protista consist of a single cell, while the biggest animals are made of millions of cells

21. Roughly how many cells are there in a human's body? How many cells are there in the smallest animal?

FIFTH GRADE D

Ecosystems (22.) Describing the interdependency of living things in a particular environment (the oxygen-carbon dioxide cycle between plants and animals; decomposed organic matter as nourishment for plants; the food pyramid, with many plants and small animals at the lower end and a few predators at the top)	22. Think about a section of the Atlantic Ocean off the coast of Boston. How do the living things there depend on each other for survival? 
(23.) Tracing the origins of a predator's food, beginning with the sun, which nourished the plants before they were eaten by an animal which was the predator's prey	23. In what sense is a fox dependent on the sun for its food? Explain.
(24.) Describing some factors that limit the number of living things in a given environment (e.g., food shortage, salinity, predators, temperature, pollution, etc.)	24. Think about a small pond with plants, frogs, fish, and microorganisms living in it. What factors might limit the number of plants and animals that can grow in the pond? Explain how that works.
(25.) Giving examples of ways that a balanced environment can be disrupted	25. What effect might each of these have on the living things in a forest? -a change in the climate -the arrival of a new species of animal -acid rain -pollution -humans hunting one kind of animal

FIFTH GRADE D

Heredity and Evolution 26. Identifying the reason for the survival of insects, fish, and plants that are the food source of many animals (the large number of offspring they produce)	26. Flies are constantly being eaten by other animals (such as frogs and spiders). Why don't flies become extinct? What helps them survive as a species?
27. Recognizing that the genetic information (genes) of the father and mother combine in sexual reproduction and start the growth of new individuals, each of whom is unique (with the exception of identical twins) because there are so many possible combinations of the mother's and father's genes	27. When does the growth of a new living thing (such as a deer) begin? Why are all living things (except identical twins) different?
28. Recognizing that the weakest and least well-adapted animals in any species are constantly being killed off by predators, the shortage of food, and other causes, so that usually only the strongest and best adapted survive (natural selection)	28. Explain the process of <u>natural selection</u>. What kinds of plants and animals do not survive? What are some things that kill them? What kinds of plants and animals survive?
29. Identifying human characteristics that make us uniquely adaptable to many environments - larger and more complex brain, skillful hands, upright posture, etc.	29. Humans can live in many different environments, from the North Pole to the rain forests near the equator, from the deepest oceans to outer space. What is it about humans that makes us so much more adaptable than other living things on Earth?
30. Recognizing that humans are cared for and protected by their parents longer than any other animal	30. Name the living species that cares for its young longer than any other.

FIFTH GRADE E

E. HUMAN BIOLOGY AND HEALTH **Anatomy** (1.) Identifying the most common kinds of human cells - nerve, muscle, blood, bone, and skin - and recognizing that they are formed as each individual grows from a single cell inside its mother	1. Each person starts life as a single fertilized cell inside his or her mother. What happens to that cell as the person develops? Name some of the different kinds of cells that develop.
2. Defining cells, tissue, organ, and system, and recognizing the order of increasing complexity in that list	2. Tell about each of these in the human body, giving an example: -organ -tissue -system -cell Now put them in order from the smallest and simplest to the largest and most complex.
(3.) Briefly describing the function of the major systems in the human body: digestive, circulatory, respiratory, skeletal, muscular, and nervous [maintained]	3. Tell briefly what each of these systems does in our bodies: -digestive system -circulatory system -respiratory system -nervous system -skeletal system -muscular system
4. Identifying the four types of joint in the human skeletal system (ball-and-socket, hinge, saddle, and pivot)	4. Name the four kinds of joints in our bodies. Point out a place where each is located.
5. Naming some voluntary and involuntary muscles in the human body	5. Our bodies have <u>voluntary</u> muscles, which work when we tell them to, and <u>involuntary</u> muscles, which work without our having to think about it. Give three examples of each.
6. Describing the structure of the digestive system, from salivary glands to excretion	6. Describe the journey of a piece of food through your digestive system. Name the different glands and organs along the way, and tell what each one does to help digest food.

FIFTH GRADE E

(7.) Identifying the brain as the control center of the nervous system, sending nerve impulses to all parts of the body through nerve "wires"	7. What is the "central computer" in your body? How does it send "commands" to your legs, arms, vocal cords, stomach, etc.?
(8.) Tracing the route taken by the oxygen you inhale: down to the lungs; through the membrane and into a red blood cell; back to the heart through the pulmonary vein; pumped through the aorta into a lesser artery; passed through a capillary and absorbed by a cell somewhere in the body; combined with a carbon atom into a carbon dioxide molecule; back into the bloodstream; back to the heart in a vein; pumped to one of the lungs; back through the membrane into one of the sacs; and exhaled	8. Trace the journey of a tiny amount of oxygen through your body, from the moment you breathe it in to the moment you breathe it out. How does oxygen help keep our bodies alive?
(9.) Recognizing that the heart beats faster when we exert ourselves, pumping more blood and nutrients to muscles and other cells, and slows down when we rest	9. When does your heart beat faster? When does it beat more slowly? Put these activities in order from those that have the fastest to the slowest heartbeat. -sitting in a chair reading -walking home from school -sleeping -running a mile -watching an exciting television show
(10.) Identifying the difference between arteries and veins (arteries carry fresh blood from the heart to the body's tissues; veins carry blue blood back to the heart), and the difference in seriousness in a cut involving a vein and an artery (a cut in an artery is much more serious)	10. What kind of blood do arteries carry? What kind of blood do veins carry? In which is blood carried away from the heart? In which is blood carried back to the heart? Is it more dangerous to cut an artery or a vein? Why?
(11.) Identifying ways the body controls bleeding (clotting) and other ways to control it (bandages, tourniquets)	11. When you cut yourself, what does your body automatically do to help stop the bleeding? In cases where the bleeding is very serious, what can you (or someone else) do to stop it?

FIFTH GRADE E

12. Describing the stages of the human life cycle from fertilized egg to full-grown adult	12. What stages of growth does each person go through, starting with the fertilized egg inside his or her mother? You should be able to think of at least seven stages.
13. Distinguishing between inherited and acquired traits (maintained), and between innate and learned behavior	13. Which of these is <u>inherited</u> and which is <u>acquired</u>? -your skill at playing chess -the color of your eyes -the color of your skin -your ability to read Which of these is <u>innate</u> and which is <u>learned</u>? -blinking your eyes -being able to type -breathing -being able to ride a bicycle
14. Identifying some psychological and social as well as physical needs of human beings (love, companionship)	14. All people need water, food, rest, etc. to stay alive. What else do we need besides the physical necessities?
Health and Nutrition 15. Identifying the five food groups with examples of each, and spotting which of the first four groups is not represented in a day's meals and snacks -fresh fruits and vegetables -whole grain breads and cereals -dairy products -meat, eggs, nuts, beans, etc. -"junk foods" - candy, cookies, chips, soft drinks, etc.	15. What are the five food groups? Give at least two examples of food in each group. Now tell which food group is not represented in this day's meals and snacks: -coffee and doughnuts -apple -milk, salad, cheese pizza -cookies, Pepsi -potato chips, root beer -salad, bread, butter, fruit, yogurt -ice cream, brownies
16. Identifying some factors that determine whether people get sick - exposure to germs; immunity; general health	16. Why do some people catch colds and other diseases more easily than others? What steps can a person take to be less likely to being infected by germs?

FIFTH GRADE E

(17.) Identifying a few common drugs, and describing their effect on the body	17. Which of these are drugs? Tell briefly what effects each drug on the list has on the human body. -milk -coffee -tea -tobacco (cigarettes, cigars, etc.) -marijuana -aspirin -penicillin -heroin
18. Describing addiction as an almost uncontrollable craving for a substance based on certain properties it possesses (e.g., for cigarettes because of the nicotine they contain, for heroin, etc.)	18. What does it mean to be <u>addicted</u> to something? Give a few examples.
(19.) Differentiating between ailments that one can treat oneself, and those that require a doctor's care	19. Which of these could you take care of yourself, and which should you see a doctor about? -a concussion -the flu -pneumonia -a mild headache -a stomach ache after a huge meal -a broken leg
(20.) Recognizing indicators of bodily distress	20. How does a person act when undergoing each of these? -heart attack -suffocation -choking on food -going into shock -stroke
(21.) Identifying temperatures over 98.6 degrees Fahrenheit as a symptom of disease, the higher above normal temperature, the more serious the illness (but recognizing that there are individual variations in temperature range)	21. If you took your temperature and got each of these readings, what conclusions would you draw? -98.3 degrees -98.6 degrees -99 degrees -100 degrees -102 degrees -104 degrees

FIFTH GRADE E, F

(22.) Describing the basic procedures a doctor performs in a physical examination (pulse, temperature, blood pressure, reflexes, etc.)	22. When a doctor gives you a regular physical examination, what does he or she look at?
(23.) Recognizing that shots build up our immunity to certain diseases by stimulating antibodies	23. Why are inoculations (shots) important? What does it mean to be immune to a disease? How was life different for children and grown-ups before immunizations were invented?
Safety (24.) Describing the recommended steps for escaping from a burning building: -leaving immediately -crawling to avoid smoke -breathing through a wet handkerchief -using stair, not elevators	24. If you are in a large department store and find out there is a fire, what steps should you follow? What are some things you should <u>not</u> do?
(25.) Identifying major safety hazards for this age group, and describing ways to minimize the risks of each one: -pedestrian accidents -injuries in automobile accidents (seat belts) -bicycle accidents -fire (see above) -tools of various kinds -toxic substances (asbestos, etc.) -eye injuries -swimming -sports, especially hockey and football	25. Make a list of ways that children your age are sometimes injured or killed. By each item on your list, tell some ways that you can cut down your risk of being a victim.
F. PHYSICAL SCIENCE **Matter** (1.) Identifying the characteristics of the three kinds of matter: -solids have a definite volume and shape -liquids have a definite volume but take the shape of their container -gases have no definite volume or shape	1. Describe what matter is like in each state (solid, liquid, and gas).

FIFTH GRADE F

2. Recognizing that atoms are the basic unit of all matter, and that there are only about 100 different kinds of atoms	2. What are the basic building blocks of all matter? About how many different kinds are there? Give a few examples.
3. Recognizing that all matter is composed of atoms, some in the form of "pure" elements (such as iron, gold, oxygen) and some in the form of compounds and mixtures	3. Which of these is a true statement? -All matter is made up of pure elements. -All matter is made up of mixtures of elements. -All matter is made up of compounds. -Matter is made of a variety of pure elements, mixtures, and compounds.
4. Identifying the relative size of atoms, molecules, cells, and a grain of sugar	4. Put these in order from the smallest to the largest: -a cell -a grain of sugar -an atom -a water molecule
5. Giving examples that prove that, volume for volume, heated air is less dense than cooler air and will rise	5. How would you show that hot air is less dense than cool air? Describe a simple experiment.
6. Recognizing that gases denser than air will sink in air, and gases less dense than air will rise in air; that things heavier than water will sink in water, while those lighter than water will float in water	6. Why do some things float and others sink in water? What is the difference between them? Why do some gases rise and others sink in the air? What is the difference between them?
(7.) Distinguishing between solutions (sugar in tea, chlorine in a swimming pool) and some mixtures (air; a combination of oxygen, nitrogen, and other gases)	7. Give an example of a <u>solution</u> and a <u>mixture</u>. What is the difference between solutions and mixtures?
Heat and Energy 8. Naming at least five different manifestations of energy, and giving examples of how one form can be changed into another	8. Make a list of at least five different forms of energy. Give some examples of how one form can be changed to another.

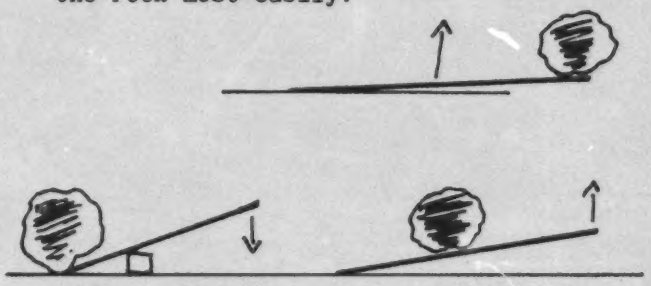
FIFTH GRADE F

9. Tracing the flow of energy back from an immediate situation to the sun (e.g., a toaster heating up, electricity came through wires, the electricity was generated by oil burning in a power plant, the oil was brought up from under ground; the oil was originally formed by dead animals decaying under pressure; those animals ate plants; those plants grew in sunlight)	9. The hot water that comes out of the tap in your house contains heat energy. Explain how this energy originally came from the sun, tracing every step.
10. Describing how electricity is produced from fossil fuels, and specifically, how our electricity in Boston is produced	10. How and where is the electricity in your home made?
(11.) Calculating the amount of electrical energy consumed by a household appliance, given information about the appliance	11. An air conditioner consumes 1.3 kilowatts per hour at full power. Electricity costs $.09 per kilowatt hour. How much will it cost to run the air conditioner for ten hours on a very hot day? [Enrichment project: take measurements on the electrical meter in your home every day at the same time, and chart the differences from day to day. What explains the variations?]
(12.) Describing the advantages and disadvantages of several kinds of energy in everyday use (e.g., coal, which is abundant and cheap but often pollutes the air; wind power, which is abundant and cheap, but not present in all locations and difficult to harness)	12. What are some advantages and disadvantages of each of these sources of energy? -coal -gasoline -diesel fuel -nuclear power -passive solar power -photovoltaic cells -wind power -geothermal power -hydroelectric power (dams)
13. Recognizing that heat usually travels from a warmer to a cooler place, and giving examples of three possible methods of transfer: conduction, convection, and radiation	13. If one room in your home is warm and the other rooms are cold, what will happen to the heat in the warm room if the door is left open? What are three ways that heat moves from hotter to cooler places?

FIFTH GRADE F

(14.) Identifying materials that are good conductors and poor conductors of heat	14. If you wanted to pick up a hot pan, what materials would best protect your hands from the heat? What materials would conduct the heat right through to your hand?
Electricity and Magnetism (15.) Grouping objects that are magnetic and non-magnetic (maintained), and recognizing how a piece of iron can be made magnetic by wrapping wire around it and passing DC electricity through the wire	15. Which of these are magnetic? -plastic -iron -aluminum -cobalt -wood -glass -the human body How can you turn a piece of iron into a magnet by using a piece of wire and a battery?
16. Recognizing that electricity can be generated by moving wires through a magnetic field	16. If you had a strong magnet, a length of wire, and a light bulb (but no battery), could you get the bulb to light up? How?
17. Identifying sources of current electricity (dry and wet cells, generators) and static electricity (lightning, friction of certain substances)	17. What are two places we get <u>current</u> electricity? What are two places we get <u>static</u> electricity?
(18.) Describing a switch as a break in an electric circuit that can be closed or opened to start or stop the flow of electricity in the circuit	18. How does an electrical switch work?
(19.) Describing the difference between the three kinds of electrical circuit; describing how they work and giving applications for each	19. Tell how each kind of circuit works, and where each is used: -simple -parallel -series
(20.) Giving examples of materials that are electrical conductors (copper, steel) and insulators (glass, wood), and giving everyday applications of the use of insulators to prevent electric shocks	20. Name at least four materials that conduct electricity well (conductors), and at least four that do not conduct electricity well (resistors or insulators). What are some ways that insulators are used to prevent injuries?

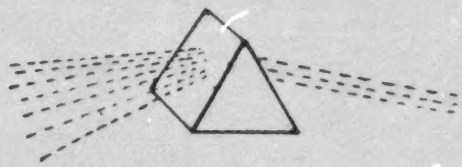
FIFTH GRADE F

21. Identifying fuses and circuit breakers as safety devices to protect people from electrical fires	21. What do fuses and circuit breakers do? Why are they required by law?
Mechanics 22. Describing ways that the six simple machines are used in everyday situations to make work easier	22. Name at least one way that each of these simple machines is used to help do work: -levers -pulleys -inclined planes -wheels and axles -screws -wedges
23. Identifying which of three possible lever arrangements would require the least work to lift a rock	23. Which of these three levers would lift the rock most easily? 
24. Identifying the variable that makes it easier or harder to do work with a mechanical device, e.g.: -the length of the effort-arm as compared with the load-arm -the slope of an inclined plane -the narrowness of the angle of a wedge	24. What could you change in each of these mechanical devices to make the work <u>easier</u>? -a steep ramp up into a truck -a lever used to lift a rock -a wedge used to split wood
25. Identifying materials that cause a great deal of sliding friction, and naming other materials that cause very little friction	25. If you were pulling a box across a floor, what floor materials would cause the most friction? What would cause the least?
26. Recognizing that the Earth's gravity pulls objects straight down toward the center of the planet, and that this is true of air and water as well as solid objects	26. What holds people, houses, trees, water, air, etc. on the surface of the Earth? Why don't they float off into space?

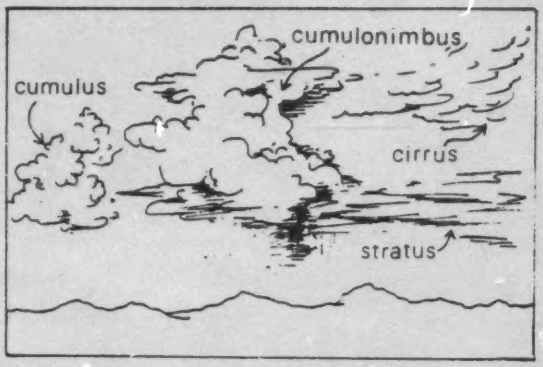
FIFTH GRADE F

27. Drawing simple diagrams showing the forces (with arrows) that are acting on a cart rolling down hill (gravity, friction)	27. As a car rolls down a hill, what two forces are acting on it? Draw a diagram showing those forces with arrows.
28. Describing the motion of a swinging pendulum and identifying the length of the arm as the variable that influences how long each swing takes; recognizing that even as the amplitude of the swing decreases, the length of time taken by each swing remains the same	28. a. If you had two grandfather clocks, one with a pendulum three feet long and the other with a pendulum four feet long, which pendulum would take the longest for each back-and-forth movement? b. A pendulum takes five seconds to go back and forth when it was swinging high. How long will it take to go back and forth when its swing is lower? When it has almost stopped swinging?
Sound (29.) Recognizing that sound is a form of energy, and that it is transmitted from one place to another by making something in between (air, wood, etc.) vibrate; giving examples of how sound can be transmitted through something other than air (e.g., through a metal pipe), and how it is <u>not</u> transmitted in the vacuum of outer space	29. Explain why sound cannot travel between two astronauts floating in space (unless they use their radios).
(30.) Describing how high- or low-pitched sounds can be produced on various musical instruments; identifying the length and tautness of the string or air column as the key variable; making a similar analysis of our vocal cords	30. How can you make a guitar string produce a higher or lower note? How can you make a drum produce a higher or lower note? What makes our vocal cords produce higher or lower noises?
Light (31.) Identifying some properties of light: -it travels in a straight line -it can be reflected by a mirror, leaving the surface of the mirror at the same angle at which it entered -it is refracted (bent) by passing through glass or water -it can be focused or spread out by lenses or curved mirrors	31. How do rays of light behave when they: -shine out of a flashlight -shine into a mirror -shine through thick glass or water -shine through a lens

FIFTH GRADE F, G

(32.) Describing how white light can be separated out into a spectrum of colors	32. What happens to white light when it passes through a prism? 
G. EARTH SCIENCE **Weather** 1. Describing how light energy from the sun is changed into wind energy on Earth (uneven heating)	1. How do the sun's rays cause winds to blow?
2. Identifying temperature differences beween land and bodies of water as the cause of on-shore and off-shore breezes [Underlying principle covered in fourth grade: water heats up and cools off more slowly than land does]	2. At what time of day does a breeze blow from the ocean toward the land (on-shore)? At what time of day does a breeze blow from the land onto the ocean (offshore)? What causes these breezes?
(3.) Defining the water cycle as the constant movement of water into the clouds by evaporation and condensation and back to the Earth through precipitation	3. Describe how the <u>water cycle</u> works.
(4.) Describing conditions of the atmosphere necessary for the formation of various forms of precipitation (e.g., below-freezing temperatures for snow, collision of air masses for rain)	4. What conditions cause rain? Snow?
(5.) Defining humidity as the amount of moisture in the air, and recognizing that warm air can hold more moisture than cool air	5. What is humidity? Why are there more humid days in the summer than in the winter? How can warm air holding 80% humidity suddenly be changed to 100% humidity and yield rain?

FIFTH GRADE G

6. Identifying three types of clouds by observing them in the sky or looking at drawings or photographs	6. Sketch three different kinds of clouds and write the name of each one. 
7. Describing what takes place in the different layers of the atmosphere: -troposphere - the weather -stratosphere - air movement, ozone layer -ionosphere - radiation belts	7. What takes place in each level of the Earth's atmosphere? -troposphere -stratosphere -ionosphere
(8.) Recognizing that when an air mass moves from one place to another, it brings weather with it	8. What often happens when an air mass moves from Canada into New England?
9. Explaining the basic reason for air pressure: the weight of many miles of air in the atmosphere being pulled down by gravity	9. Why does air push on our bodies with a force of 15 pounds per square inch (air pressure)?
10. Identifying some conditions that can change air pressure (wind, temperature), and recognizing that changes in atmospheric pressure are associated with changes in weather	10. Why is the air pressure always changing? What usually accompanies a change in air pressure?
(11.) Identifying a barometer as an instrument that measures air pressure, and recognizing that when the needle is on higher readings, the weather is usually fairer than when the needle is on lower readings	11. What does a barometer measure? Explain what you could learn from a barometer's readings.

FIFTH GRADE G

(12.) Making a prediction of tomorrow's weather based on readings from a thermometer, a wind gauge, a wind vane, and a barometer	12. Teacher observation
(13.) Identifying the major symbols used on a weather map in the newspaper	13. Explain the symbols on this map:
Geology 14. Identifying the Earth's crust and mantle on a schematic drawing, and knowing their relative thickness	14. Draw in and label the crust and mantle on this cross-section of the Earth.
(15.) Recognizing that the Earth's surface is constantly being built up and worn down by geological forces (heat and pressure; folding and faulting; volcanoes and earthquakes; erosion and scouring, etc.)	15. How has the Earth's surface been changed over the eons? What forces are responsible for changing it? Will the Earth continue to change in the years ahead?
16. Recognizing that geologists believe the Earth is about 4-1/2 billion years old and have divided the Earth's history into eras and periods (e.g., Cambrian, Pre-Cambrian, etc.)	16. How old do geologists believe the planet Earth is? Name two of the eras into which geologists have divided the Earth's history.
(17.) Identifying the three kinds of rock (igneous, sedimentary, and metamorphic), and listing the order in which they were formed	17. What are the three kinds of rock on Earth? Which kind was formed first? Which kind was formed most recently?

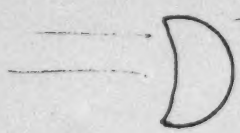
FIFTH GRADE G

(18.) Explaining why there are few fossils of some animals and many fossils of others (soft-bodied animals are much less likely to be preserved in rock)	18. Why are there so many more fossils of animals with shells and bones than of animals without shells and bones?
(19.) Recognizing that rocks are constantly being broken up into smaller pieces, sand, clay, etc., by water, wind, chemical reactions, temperature changes, and plant growth	19. How are sand and clay formed?
(20.) Recognizing that topsoil is formed from tiny particles of rock mixed with decaying material from plants and animals (maintained), and describing the role of bacteria and worms in producing topsoil	20. How is topsoil formed?
21. Describing how you can tell the quality of topsoil according to the amount of organic material it contains to how well each can hold water	21. How can you tell whether a particular sample of soil is good for growing plants?
22. Describing the way in which the basic molecules on Earth are constantly being recycled	22. How could an atom that was part of a dinosaur's body 300 million years ago be part of your body today? Explain.
23. Identifying geysers and hot springs as phenomena that bring dissolved minerals to the Earth's surface	23. What are some ways that minerals are carried from the Earth's interior to the surface?
24. Describing how limestone caverns are formed by the action of water seeping through the Earth, dissolving and carrying away limestone, and leaving an open space	24. Tell how underground caverns are usually formed.
(25.) Recognizing that the saltiness of the ocean is caused by the many minerals that have been dissolved by rivers, lakes, and the ocean, as well as by the decaying bodies of plants and animals	25. Why does the ocean taste salty?

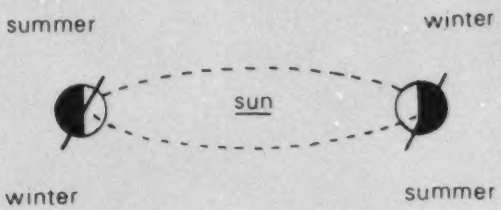
FIFTH GRADE G, H

26. Identifying some uses of rocks and minerals - building materials, abrasives, metal ore, gems, etc.	26. Name at least five ways that people use rocks and minerals.
(27.) Distinguishing between renewable and non-renewable resources	27. Which of these are <u>renewable</u> and which are <u>non-renewable</u> resources? -trees -gold -aluminum -coal -oil
H. ASTRONOMY **The Solar System** (1.) Recognizing that the sun is a star composed of intensely hot gases, and that the sun has nine known planets in nearly circular orbits around it [maintained]	1. What is the sun composed of? How many planets orbit the sun, and what is the shape of their orbits?
(2.) Giving the names and order from the sun of the nine known planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto [Note: Pluto's eccentric orbit means that this planet is sometimes closer to the sun than Neptune.]	2. Write the names of the known planets of our solar system in the order of their distance from the sun, starting with the closest.
(3.) Recognizing that in addition to the sun and the nine known planets, our solar system contains a number of satellites, planetoids, asteroids, meteors, and comets	3. What does our solar system contain besides the sun and planets?
(4.) Recognizing that the planets all orbit the sun in the same direction, and that all except Uranus rotate on their axes in the same direction	4. True or false: a. All of the planets orbit the sun in the same direction b. All the planets spin on their axes in the same direction.
(5.) Recognizing that Earth is almost certainly the only planet in our solar system that can sustain life (it is close enough to the sun, but not too close, to provide the right conditions)	5. Which planet(s) in our solar system can support life? Why?

FIFTH GRADE H

(6.) Recognizing that the sun is a little over a million times larger than the Earth in volume, so that if the sun were the size of a large beach ball, the Earth would be the size of a small pea [The exact ratio is 1,300,000:1]	6. How much bigger than the Earth is the sun? Compare their sizes by comparing them to everyday objects.
Beyond the Solar System (7.) Recognizing that our sun is part of the Milky Way galaxy, which contains billions of other stars	7. What is the name of the large collection of stars of which our solar system is a part? About how many stars does it contain?
(8.) Identifying constellations as groups of stars that happen to be arranged in ways that reminded humans of certain forms, and naming several constellations	8. What are constellations? Name a few.
(9.) Recognizing that different constellations are overhead at different times of the year; describing the kinds of predictions about human personality and fate that are made on the basis of the stars under which people are born (astrological charts)	9. Under which constellation were you born? How can different people be born under different constellations? What does astrology say is the significance of your constellation?
(10.) Recognizing that almost all scientists believe that astrology has no basis in fact	10. What do most scientists have to say on the issue of astrology as a true science?
The Moon 11. Inferring the location of the sun, given a picture of the moon in any phase	11. In this picture of the moon, draw an arrow showing which direction the sun in shining from. 
(12.) Making a rough sketch to describe how a lunar eclipse occurs (the Earth comes between the sun and the moon, with all three lined up perfectly, and casts its shadow on the moon)	12. Draw a diagram showing how a lunar eclipse happens.

FIFTH GRADE H

Space Travel 13. Describing the stages of a rocket trip to the moon and back (escaping the Earth's gravity; travelling to the moon; going into orbit around the moon; landing, exploration, and take-off; and the return)	13. Write an account of the Apollo spacecraft's trip to the moon; tell about all the stages of the trip.
The Seasons 14. Identifying the orbit of the Earth around the sun as elliptical (we are a little closer to the sun in January and a little further away in July), and recognizing that these variations have nothing to do with the changes in temperature between summer and winter	14. What is the shape of the Earth's orbit around the sun? When the Earth is closest to the sun, does the Earth get hotter? Explain.
(15.) Recognizing that what makes our winters colder in Boston is the fact that the sun is lower in the sky and its rays have to shine through more atmosphere before they reach us, losing heat energy in the process [maintained]	15. Why is it colder in Boston in the winter than it is in the summer?
16. Recognizing that the Earth's axis is tilted slightly in relation to the sun [the exact angle is 22-1/2 degres]	16. Draw a diagram showing the Earth and the sun, and show the approximate angle of the Earth's axis to the sun.
(17.) Recognizing that as the Earth moves around the sun, first the northern hemisphere, then the southern hemisphere, is tilted away from the sun	17. How does the tilt of the Earth's axis affect the way the northern and southern hemisphere are exposed to the sun's rays?
(18.) Recognizing that it is this successive tilting toward and away from the sun that causes the changes in our seasons	18. Why does Boston have different weather in the spring, summer, autumn, and winter? 

FIFTH GRADE I

I. SCIENCE READING	I. SCIENCE READING
(1.) Reading at least three of the following science books or magazines, either as a part of the individual project (objective A-2), or as a separate activity	1. Teacher observation and record keeping

FOURTH AND FIFTH GRADE SCIENCE BOOKS

Adams	Catch a Sunbeam: Book of Solar Study Experiments
Adkins	Moving Heavy Things
	Wooden Ship: The Building of a Sailing Vessel
Adler	The Calendar
Adrian	Secret Neighbors: Wildlife in a City Lot
Alth, Charlotte and Max	Disastrous Hurricanes and Tornadoes
Anderson	Junior Science Book on Sound
	Halley's Comet
	The Smallest Life Around Us
Andrews	In the Days of the Dinosaurs
Arnold	The Great Science Magic Show
Arnov	Water: Experiments to Understand It
Asimov	How Did We Find Out About Oil?
Aylesworth	It Works Like This
Bare	Ground Squirrels
Barkin	How to Keep a Secret: Writing and Talking in Code
Baumann	Monsters of North America
Bendick	Exploring an Ocean Tide Pool
	Mystery of the Loch Ness Monster
Berger	Computers in Your Life
	Medical Center Laboratory
	Disease Detectives
	Quasars, Pulsars, and Black Holes in Space

FIFTH GRADE I

	Whole World of Hands
Bershad	Bodyworks: Kids' Guide to Food and Physical Fitness
Bevans	Book of Reptiles and Amphibians
Billings	Salamanders
Bixby	Hurricanes
Blassingame	Skunks
	Wonders of Raccoons
Bliss, Sands and Co.	The Magic Moving Picture Book
Blumberg	UFO's
	Sharks
Bosiger	A Bird Is Born
Boy Scouts of America	Official Boy Scout Handbook
Brady	Wild Babies: A Canyon Sketchbook
	Wild Mouse
Bramwell	Rand McNally Atlas of World Wildlife
Branley	Columbia and Beyond: Story of the Space Shuttle
	The End of the World
	Feast or Famine: The Energy Future
	Book of Mars for You
Brindze	Hurricanes: Monster Storms From the Sea
Bronson	Coyotes
Brown, Joseph	Knowing the Outdoors in the Dark
	Grass: An Illustrated History with Recipes
Brown, Walter	Historical Catastrophes: Famines
	Historical Catastrophes: Floods
Buck	Where They Go In Winter
Budlong	Experimenting with Seeds and Plants
Burns	The I Hate Mathematics Book
Burstein	Slim Goodbody: What Can Go Wrong and How to Be Strong
Burton	Life Story
Bygrave	Motorcycle
Carlo	The Juggling Book
Carrick	Crocodiles Still Wait
Challand	Science Activities From A to Z

FIFTH GRADE I

Charlip	Hand Talk
Charlip and Joyner	Thirteen
Cherrier	Fascinating Experiments in Physics
Cherry	Steel Beams and Iron Men
Clemens	Superanimals
Cobb	Science Experiments you can eat
	Bet You Can't! Science Impossibilities to Fool You
Cohen	Color of Man
	Ancient Visitors
Colby	Undersea Frontiers
	Hidden Treasure: What, Where, and How to Find It
Cole	Fleas
	Frog's Body
Cook	Closer look at the Apes
Coombs	Skylab
Cooper	Science in Your Own Backyard
Corbett	Bridges
Cosgrove	Bone for Bone
Craig	Dinosaurs and More Dinosaurs
Crocker	New, Good and Easy Cookbook
Crosby	Tarantulas: Biggest Spiders
Curtis	Cindy: A Hearing Ear Dog
	Greff: Story of a Guide Dog
Darling	The Gull's Way
	Worms
	Turtles
Davis	Biography of a Fish Hawk
	Into the Dark: A Beginner's Guide to B&W Negative
Dean	How Animals Communicate
Deguine	Emperor Penguin: Bird of the Antarctic
Demuth	City Horse
Dennis	Catch the Winds: A Book of Windmills and Wind Power
De Regniers	The Shadow Book
Dietrich	Stones: Their Collection, Identification, and Use

FIFTH GRADE I

Dobin	Great Men of Science
Dobrin	Marshes and Marsh Life
Earle	Camels and Llamas
Eberle	Elephants Live Here
Edwards	Caring for Trees on City Streets
Ennion and Tinbergen	Tracks
Faulkner	The Days When the Animals Talked
Fichter	Keeping Amphibians and Reptiles as Pets
Fields	Sun
	Stars and Planets
	Insects
Flanagan	Window into an Egg
Fletcher	Fishes Dangerous to Man
Fodor	Angry Waters: Floods and Their Control
	Frozen Earth: Exploring the Ice Ages
Ford and Kelper	The Island Ponies
Foster	Keeping the Plants You Pick
Freedman	Animal Superstars: Biggest, Strongest, Fastest
	Tooth and Claw: A Look at Animal Weapons
	Getting Born [animals]
	How Birds Fly
	Hanging On: How Animals Carry Their Young
Freeman	Blimps: On the Move
	Story of Electricity
	When Air Moves
Gallant	Constellations: How They Came to Be
Gallob	City Rocks, City Blocks and the Moon
	City Leaves, City Trees
Gardner	Magic Through Science
Gemming	Born In a Barn: Farm Animals and Their Young
Giambarba	Surfmen and Lifesavers
Gibbons	Clocks and How They Go
Gilbert	Fat Free: Common Sense for Young Weight Worriers
	Science-Hobby Book of Terrariums
Gilmore	Model Boats for Beginners
Gilmour	Understanding Your Senses

FIFTH GRADE I

Girl Scouts of USA	Worlds To Explore
Goetz	Tropical Rain Forests
Goldreich	What Can She Be? A Scientist
	What Can She Be? A Computer Scientist
Goudey	Houses From The Sea
Graham	Bug Hunters
	Falcon Flight
	Coyote Song
	Whale Watch
Grillone	Small Worlds Close Up
Gross	What Is That Alligator Saying?
	Alligators and Other Crocodilians
Haber	Women Pioneers of Science
Haines	Cancer
Hamerstrom	Adventure of the Stone Man
Hancock	Supermachines
Harris	Biography of a Whooping Crane
	Creatures With Pockets
	Crocodiles and Alligators
	Boats and Ships
	Helicopters
	Mouse Woman and the Muddleheads
Hayden	Eight Black American Inventors
	Seven Black American Scientist
Hellman	Lever and the Pulley
Henrie	Dogs
	Cats
	Birds at Home
Herbert	Mr. Wizard's Supermarket Science
Hess	Amazing Earthworms
	Life Begins for Puppies
	Sea Horses: Story and Photographs
	A Snail's Pace
	Pigeons Everywhere
	Mouse and Company
	The Misunderstood Skunk

FIFTH GRADE I

	Bird Companions
Heuer	Rainbows, Halos and Other Wonders
Hewett	Watching Them Grow: Inside a Zoo Nursery
Hillcourt	Fun With Nature Hobbies
Hirschman	In a Lick of a Flick of a Tongue
Hiss	Giant Panda Book
Hoffmeister	Zoo Animals
Hofsinde	Indian Music Makers
Holbrook	A Closer Look at Elephants
Holling	Paddle-to-the-Sea
Hopf	Biography of a Rhino
	Biography of a Snowy Owl
	Biography of an American Reindeer
Hornblow	Animals Do the Strangest Things
	Insects Do the Strangest Things
	Birds Do the Strangest Things
	Reptiles Do the Strangest Things
Horowitz	How to Wreck a Builing
Hosking	Kites Aussie Style
Hughes	A Closer Look at Bees and Wasps
Hutchi	Look at Ants
Hutchings	Things That Go Word Book
Hutchins	Saga of Pelrus Jack
	Travels of Monarch
Ipsen	Rattlesnakes and Scientists
Isenbart	A Duckling Is Born
Italiano	Sleighs: The Gentle Transportation
Jacobs	Supersaurus
Johnsen, Jan	Gardening Without Soil
Johnson, Hannah	From Seed to Jack-O'-Lantern
	Story of Otters
	Creating With Paper
	Silkworms
Jones	Knead It, Punch It, Bake It: Make Your Own Bread
	Television Magic
Kamien	What If You Couldn't...? A Book About Special

FIFTH GRADE I

	Needs
Kavaker	Dangers of Noise
Keen	Be a Rockhound
Keene	Beginner's Story of Minerals and Rocks
Kehoe	The Puzzle of Books
Kenworthy	Camels
Kettlekamp	Hypnosis, The Wakeful Sleep
	Shadows
Kevies	Watching the Wild Apes [Goodall, Fossey, Galdikas]
Kiefer	Poisoned Land: The Problems of Hazardous Waste
Knight	Those Mysterious UFO's
	Comets
Kohn	The Beachcomber's Book
Kraske	The Twelve Million Dollar Note
Langseth	Apollo Moon Rocks
Larsson and Rudstrom	A Farm
Lasky	Tall Ships
	Tugboats Never Sleep
	Weaver's Gift
Lauber	Earthquakes: New Scientific Ideas About How and Why the Earth Shakes
	Junior Science Book of Volcanoes
	Bats: Wings in the Night
	Seeds: Pop, Stick, Glide
	What's Hatching Out of That Egg?
Lavine	Wonders of the Eagle World
Laycock	Beyond the Arctic Circle
	Strange Monsters and Great Searches
	What Makes Me Feel That Way?
Leen	Snakes
Leister	Flying Fur, Fin and Scale
Le Shan	What's Going to Happen to Me?
Lewis	Superstructures
Life	The World We Live In
Lindblom	The Fantastic Bicycle Book

FIFTH GRADE I

Lindsay	Left-Handed Book
	Sleep and Dreams
Loss	What Is It? A Book of Photographic Puzzlers
Lubell	Birds in the Streets: The City Pigeon Book
Macaulay	Unbuilding
	Underground
	Cathedral
MacClintock	A Natural History of Giraffes
MacGregor	Skyscrapers: A Project Book
Mannetti	Dinosaurs in Your Backyard
Massie	Chameleon Was a Spy
Matteson	Draggerman: Fishing on Georges Bank
May	Wildlife in the City
Mayer	Who's Out There? UFO Encounter
McCloy	Dogs at Work
McClung	The Mighty Bears
	Amazing Egg
McFall	Wonders of Dust
McGowen	Album of Whales
	Album of Astronomy
	Album of Dinosaurs
	Album of Sharks
	Album of Prehistoric Animals
	Album of Prehistoric Man
	Album of Rocks and Minerals
McWhirter	Guinness Book of Amazing Animals
Metos	Robots A to Z
	Exploring With Solar Energy
Meyer	Miss Patch's Learn to Sew Book
	The Bread Book: All About Bread and How to Make It
	Pearson: A Harbor Seal Pup
Michel	The Story of Nim: The Chimp Who Learned Language
Miles	Save the Earth
Milgrom	ABC Science Experiments
Miller	Lambing Time

FIFTH GRADE I

Milne, Lorus and Margery	Nature's Clean-Up Crew: The Burying Beetles
Milton	Here Comes the Robots
Mitchell, ed.	A Guide to the Seasons [a publication featuring selections from the Mass. Audobon Society's Curious Naturalist]
Moche	Star Wars Question and Answer Book About Space
Morgenstern	Metric Puzzles, Tricks and Games
National Geographic	Books for Young Explorers Series
Nixon	Glaciers: Nature's Frozen Rivers
Nourse	Fractures, Dislocations and Sprains
Oliver	What We Find When We Look at Maps
Olney	They Said it Couldn't Be Done: Engineering Feats
Ommaney	Frogs, Toads and Newts
Oxford	The Oxford Book of Economic Food Plants
Paul	Kids Cooking: A First Cookbook For children
	Kids Outdoor Gardening
	Kids Indoor Gardening
Pearl	Gems, Minerals, Crystals and Ores: Collector's Encyclopedia
Perl	Junk Food, Fast Food, Health Food
Perry and Merschel	Journey Into a Hollow Tree
Pfadt	Grasshoppers
Pluckrose	Small World Series
Podendorf	True Book of Rocks and Minerals
Pollard	How Things Work
Poynter	Search and Rescue: Team and Missions
Pringle	Vampire Bats
	Chains, Webs and Pyramids
	The Hidden World
	City and Suburb: Exploring an Ecosystem
Rabinowich	Seals, Sea Lions and Walruses
	Horses and Foals
	Kangaroos, Koalas, and Other Marsupials
	Loch Ness Monster
Rahn	Seven Ways to Collect Plants
	How Plants Are Pollinated

FIFTH GRADE I

Rahn	Watch it Grow, Watch it Change
	Grocery Store Zoology
Rand, McNally	The International Atlas
Reich	World From Above
Rey	Find the Constellations
	The Stars: A New Way to See Them
Rhodes	How to Read a City Map
Rice	Getting Started in Prints and Patterns
Rich	Earth Movers
	Diesel Trucks
Riedman	Spiders
Robbins	Trucks of Every Sort
Rockwell	Wolves
Roever	Mustangs
Rublowsky	Nature in the City
Rutland	Exploring the Violent Earth
	Exploring UFO's
	Ships
Ryden	Wild Colt, the Life of a Young Mustang
Sander	The Curious World of Crystals
Sarnoff	Great Aquarium Book
Sarnoff and Ruffins	The Code and Cipher Book
Satchwell	Energy Series: Future Resources
Sattler	Dinosaurs of North America
Sawyer	Vibrations: Making Unorthodox Musical Instruments
Schaller	Wonders of Lions
Scheffer	The Seeing Eye
	Little Calf
Schlein	Giraffe: The Silent Giant
	Lucky Porcupine!
Schwartz	The Cat's Elbow and Other Secret Languages
Schwartz	Through the Magnifying Glass
Scott	Hieroglyphics for Fun: Your Own Secret Language
	Moose
	Book of the Pig
	Book of the Goat

FIFTH GRADE I

Selsam	How Animals Tell Time
	Tyrannosaurus Rex
	Night Animals
	Amazing Dandelion
	The Harlequin Moth: Its Life Story
	Bulbs, Worms and Such
Shapiro	Gift of Magic Sleep: Experiments in Anesthesia
Sharp	Simple Machines and How They Work
Shay	What Happens at the Zoo
Shebar	Animal Dads Take Over
Shepard	Jellyfishes
Shuttlesworth	Animals That Frighten People: Fact Versus Myth
	Zoos in the Making
Silverstein	Circulatory Systems: The Rivers Within
Simon	Science in a Vacant Lot
	Mirror Magic
	The Long View Into Space
	Exploring Fields and Lots
	Look to the Night Sky
	Animals in Your Neighborhood
	The Optical Illusion Book
	Tropical Saltwater Aquariums
	Pets in a Jar
Smith	Play With the Wind
Sommer	Sidewalk Fossils
Stein	How to Raise a Puppy
	How to Raise Mice, Rats, Hamsters, and Gerbils: A Child's Book of Pet Care
	How to Raise Goldfish and Guppies
Stone	Chemistry of a Lemon
	Chemistry of Soap
Sullivan	Plants to Grow Indoors
Symonds	Tree Identification Book
Taketazu	Fox Family: Four Seasons of Animal Life
Teleki	Goblin: A Wild Chimpanzee
Tongren	What's For Lunch: Animal Feeding at the Zoo

FIFTH GRADE I

Thompson	Crocodiles and Alligators
Thurman and David	The Magic Lantern: How Movies Got to Move
Van Soelen	Cricket in the Grass
Vannini and Pogliani	The Color Atlas of Human Anatomy
Walther	A Spider Might
Waters	Crab From Yesterday
	Mysterious Eel
Webber	Bits That Grow Big
Webster	Science Projects With Eggs
Weiss	How to Be an Inventor
	Hammer and Saw: Introduction to Woodworking
	Motors and Engines and How They Work
	Why Glass Breaks, Rubber Bends, Glue Sticks
Wheat	Survival Arts of the Primitive Payutes
Whitney	Whitney's Star Finder
Welch	Sunflower!
Wentz	Paper Movie Machines
Wexler	Secrets of the Venus's-Flytrap
Weyl	Men, Ants, Elephants
White	Investigating Science With Rubber Bands
Wilkins	The long Ago Lake: A Child's Book of Nature Crafts
Wolberg	Zooming in: Photographic Discoveries Under the Microscope
Wolf	Anna's Silent World
Woodside	What Makes Popcorn Pop?
Wyler	It's All Done With Numbers
Yolen	World on a String
Zappler	From One Cell to Many Cells
Zim	Waves
	Crabs
	Frogs and Toads
	Snakes
	The Universe
	Comets
Zim, ed.	Golden Field Guides:

FIFTH GRADE I

	Birds
	Trees
	Flowers
	Insects
	Stars
	Mammals
	Seashore
	Shells
	Rocks and Minerals
	Fishes
	Reptiles and Amphibians
	Zoology
Zubrowski	Bubbles: A Children's Museum Activity Book
	Ball Point Pens: A Children's Museum Activity Book
	Messing Around With Water Pumps and Siphons
	Messing Around With Baking Chemistry
	Messing Around With Drinking Straw Construction

MAGAZINES

Animals (MSPCA)
Contact
National Geographic World
Odyssey
Penny Power
Ranger Rick's Nature Magazine
Scienceland

SIXTH GRADE

A. SCIENCE EXPERIENCES

(1.) Carrying out and reporting on at least one hands-on science experiment or project, working individually or in a small group. The topics of the experience should be chosen by each student, drawing on the content for this grade level (see sections C - H) or other topics of interest. The experience is open-ended in terms of content, but should incorporate as many of the following general science processes as possible: a. Stating what you want to find out in clear and precise terms b. Planning the project or experiment, deciding what equipment and materials are needed and gathering them, and deciding whether a set of control observations is required c. Stating a hypothesis (an educated guess) about what might happen d. Carrying out the experiment or project, controlling and systematically changing variables e. Observing and describing what happened, using measurement instruments to get precise readings where necessary; testing the hypothesis f. Keeping records of data gathered g. Sorting, comparing, and classifying the information gathered, looking for patterns and regularities h. Analyzing the data, and arriving at logical conclusions i. Presenting the conclusions in oral, written, or graphic form	1. Teacher observation: By the end of the year, has the student completed and reported on at least one direct science experience which includes most of the science processes and skills? Some possible experiences: - systematically observing changes in plants and animals over time - systematically observing changes in the weather over time - performing experiments with plants and different forms of light and nutrients - making systematic observations of an aquarium or terrarium - repairing a household appliance by using the manual or other source of information - building or developing something, e.g., a computer game, amplifier, radio, electronic device, etc.
(2.) Using books (see section I), interviewing, field trips, or other experiences to find out a great deal about at least one topic, and presenting a written report on that topic	2. Teacher observation: Has the student chosen a topic, made a thorough investigation of it, and presented a written report? Some possible topics: -food processing -immunizations -pollution studies -electronic circuitry -calculators -computers -carnivorous plants -minerals

SIXTH GRADE B

B. SCIENCE SKILLS AND PROCESSES	
Observing	
1. Observing carefully; noticing such details as size, shape, color, texture, weight, smell, taste, position, time taken, etc. (using a magnifying glass or microscope when necessary)	1-13 These skills and processes should be applied and assessed in the Science Experiences, Life Science, Human Biology and Health, Physical Science, Earth Science, and Astronomy sections. Specific right-hand column examples are not given in order to encourage the application of the skills to all content areas. The subtantial overlap of these skills with those in the mathematics curriculum document makes it possible to teach many science and mathematics skills simultaneously.
2. Setting up and correctly preparing slides for a microscope	
3. Identifying ways in which different people can observe the same phenomena differently, and ways of making measurements more objective	
Measuring	
4. Identifying the appropriate measuring instrument and unit of measure for a task [Correlation with Math objectives]	
5. Measuring length in English or metric units [Correlation with Math objectives]	
6. Measuring weight in English or metric units [Correlation with Math objectives]	
7. Measuring time to the nearest second, using a clock or stopwatch [Correlation with Math objectives]	
8. Measuring temperature in degrees Fahrenheit or Celsius [Correlation with Math objectives]	
9. Measuring volume in English or metric units [Correlation with Math objectives]	

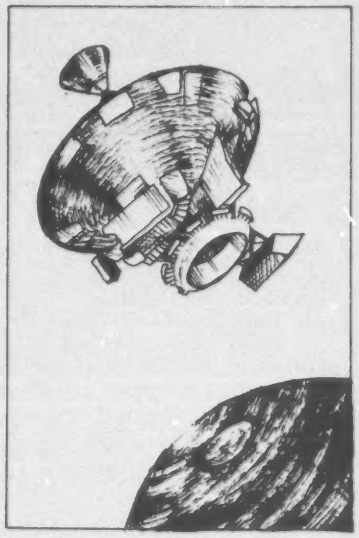
SIXTH GRADE B

(10.) Interpolating readings on measurement instruments (i.e., finding a reading between two known points on a scale when finer gradations are not given)	
(11.) Estimating length, weight, temperature, time, volume, etc. when approximate readings are adequate [Correlation with Math objectives]	
Classifying (12.) Organizing and classifying objects or information	
Recording (13.) Recording information in the form of sketches, graphs, charts, tables, etc., and interpreting information recorded in these formats by others	
Using Equipment 14. Using and maintaining laboratory equipment	14. Teacher observation
Scientific Method 15. Distinguishing between observations and inferences	15. Which of these is an <u>observation</u> and which is an <u>inference</u>? -The tree's branches are splintered and charred. -The tree must have been struck by lightning and caught on fire.
16. Distinguishing between hypotheses and predictions, and between predictions and theories	16. Which of these is a <u>hypothesis</u>, which is a <u>prediction</u>, and which is a <u>theory</u>? -Humans and apes evolved from a common ancestor. -The barometer will have a lower reading at the top of the Prudential Center than at the bottom. -I think air pressure decreases as you get higher off the ground.
(17.) Identifying the variables in an experiment	17. In the early spring, Cynthia planted flower seeds in two pots. She put one pot outside and the other in a heated greenhouse to see which would grow more quickly. What are the variables in her experiment?

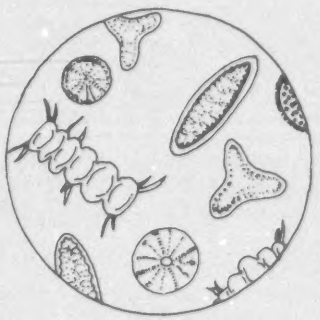
SIXTH GRADE B, C

18. Relating at least one story of how an important scientific discovery was made, describing the factors that contributed to its success (persistence, cooperation, skill, luck, etc.)	18. Tell how at least one important scientific discovery was made. How important was: -luck -hard work -teamwork -courage -persistence
19. Describing at least one case of scientific fraud and how the fraud was uncovered	19. Tell about at least one scientific fraud - a situation where a scientist made up or falsified data and tricked people into believing it was accurate. How was the fraud discovered? Here are some possibilities: -Midwife toad -Piltdown man -Cardiff giant -Cuvier hoax -Leisenkovism -Cyril Burt -William Darsee
C. SCIENCE AND SOCIETY	
1. Distinguishing between science and technology ("pure" versus applied) and giving examples of each	1. Which of these are examples of <u>science</u>, and which are examples of <u>technology</u>? -nuclear power station -automobile -DNA research -plastics factory -studying the rings of Saturn
2. Describing the impact of at least three major scientific/technological advances of the past on the development of early civilizations [link to Social Studies curriculum at this level]	2. What effect did each of these have on human civilization? -invention of the wheel -invention of agriculture -invention of the arch -discovery of steel -invention of gunpowder -invention of the telescope

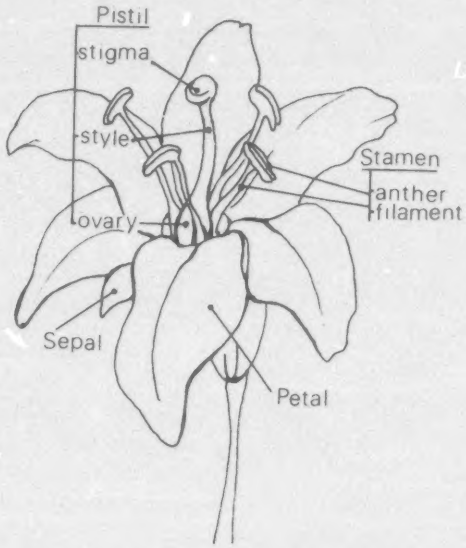
SIXTH GRADE C

(3.) **Describing the impact of at least three recent scientific/technological advances**	3. What effect has each of these had on our way of life? -television -satellites -space travel -nuclear weapons -laser beams -calculators -computers -radar -antibiotics -chemotherapy
(4.) **Identifying the <u>sequence</u> of some major scientific/technological events**	4. Put these in the order in which they were invented or developed: -nuclear weapons -nuclear power plants -automobiles -dynamite -microcomputers -planes -steel swords 
(5.) **Describing at least one current scientific or technological issue that has been in the news in the current school year (examples from previous years would include the space shuttle, toxic waste dumps, DNA research, etc.)**	5. Tell about a science story that has been reported on TV or in the newspapers this year. Why did it make news?

SIXTH GRADE C, D

(6.) Identifying some examples of "non-science", and outlining the debate between scientists and the proponents of such phenomena; some examples: -astrology -psychokinesis -parapsychology -E.S.P. -Atlantis -U.F.O.s -dowsing rods -tarrot cards -pyramid power	6. Give at least two examples of strong beliefs that some people hold that are not backed up by scientific evidence. Tell both sides of the debate between scientists and people who hold each set of beliefs. Is it important that these beliefs are not scientifically provable?
(7.) Briefly describing the contributions and some biographical details about some well-known scientists (see list in Appendix)	7. Choose at least five important scientists (make sure your list includes a mix of men and women and people of different racial and ethnic groups) and tell about their life and work.
(8.) Identifying at least three science-related vocations and avocations, and describing the education and training needed to engage in such activities	8. What are at least three hobbies and jobs involving science? What level of schooling and training are needed to qualify for each job?
D. LIFE SCIENCE Cells (1.) Describing some characteristics of microscopic life, based on observation through a microscope	1. Tell what at least two forms of microscopic life look like. Make sketches to illustrate. 
2. Identifying several kinds of single-celled organisms (paramecium, amoeba, etc.) and where they commonly live	2. Name at least three kinds of single-celled organism, and tell where you might find each one.
3. Describing the life cycle of single-celled organisms - how they grow and reproduce	3. Tell the life history of a typical single-celled organism.

SIXTH GRADE D

Plants (4.) Describing the life cycle of a flowering plant; from seed to maturity and then to reproduction	4. List the stages that flowering plants go through as they grow.
5. Describing the way pollen is transferred from the stamen (anther) to the pistil (stigma)	5. How does pollen get from the stamen to the pistil in flowering plants? 
(6.) Identifying common parts of a flower and describing the function of each: -petal -pistil -stamen -ovule -sepal -anther	6. Label the parts of a flower, and tell what each part does to keep the flower alive.
7. Identifying different kinds of molds and what they need to live	7. Name some common molds. What do they need to stay alive?
(8.) Explaining in one's own words how photosynthesis works (plants absorbing carbon dioxide in the presence of sunlight, water, and minerals from the soil to produce food [sugar] while giving off oxygen)	8. Describe the process of photosynthesis.

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9. Identifying insecticides as chemicals used to protect plants from certain insects	9. How do gardeners and farmers keep their plants from being eaten by insects?
Animals 10. Identifying the major characteristics of vertebrates and invertebrates	10. What are the important differences between vertebrates and invertebrates?
11. Identifying adaptations in a given animal's body and describing how they help it survive [maintained from fifth grade]; e.g., warm-bloodedness, camouflage, speed, etc.	11. Choose one animal and describe the way its body adaptations have helped insure its survival over the years.
12. Describing the way in which an insect can keep its shape without a bony skeleton inside its body	12. Insects don't have internal skeletons. How do their bodies keep their shape?
13. Describing the stages in the life cycle of a frog or other animal, from fertilized egg to grown animal [maintained]	13. What are the stages that a frog goes through from the very beginning to the end of its life?
14. Describing the purposes of various forms of animal behavior [maintained]	14. What purpose does each of these animal behaviors serve? -migration -hibernation -territoriality -pecking order -social colony
15. Identifying ways that humans use animals (companionship, entertainment, work, food, laboratory experiments), and giving examples of each	15. Give at least ten examples of ways that people use animals.
16. Becoming familiar with the moral issues surrounding human interactions with animals	16. Some people feel very strongly that humans mistreat animals. What uses of animals bother these people? What are the arguments on both sides?
17. Describing (or sketching) a cell and its membrane	17. What does a typical cell look like? Make a rough sketch of a cell showing its most important parts.

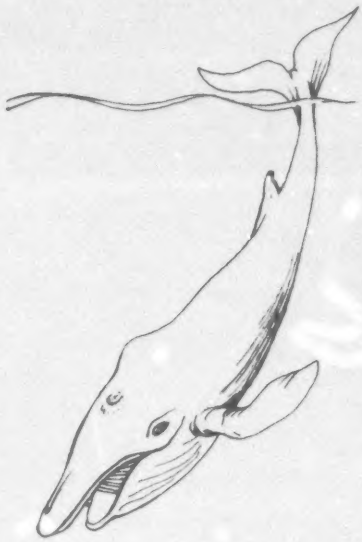
SIXTH GRADE D

18. Recognizing the way in which the cells of organisms specialize as the organism grows from a single fertilized egg (some becoming blood, some becoming bones, some nerves, etc.)	18. An elephant begins its life as one fertilized cell. Describe what happens to that cell in the first few months of the elephant's life.
(19.) Identifying the basic materials that cells need to maintain life	19. What do cells need to stay alive?
(20.) Describing the way that cells reproduce themselves by cell division (splitting in two, four, eight, etc.)	20. How does one cell become many cells?
Ecosystems (21.) Recognizing that plants depend on sunlight to turn carbon dioxide into oxygen	21. Why don't plants give off oxygen at night?
(22.) Describing an ecosystem - a population interacting with its physical surroundings - in terms of its main ingredients (sunlight, water, the temperature range, the plants, microorganisms, insects, small animals, and predators who live in it)	22. What is an ecosystem? Give an example, and describe how it works.
(23.) Describing a complex food chain (or web) in an environment with a number of living things	23. How do the following parts of a food chain depend on each other? Crickets, salamanders, mushrooms, rabbits, foxes, mice, and humans

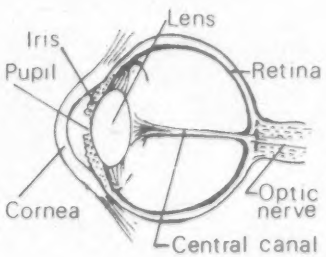
SIXTH GRADE D

24. Tracing a pollutant that does not break down (such as DDT) through a food pyramid; observing that it becomes more concentrated at the higher levels	24. After insects eat plants with DDT on them, what happens to the DDT? At what point in the food pyramid does the DDT do the most damage?
25. Identifying some long-range environmental problems caused by human activities (e.g., increased carbon dioxide in the atmosphere possibly leading to an increase in temperatures worldwide)	25. Describe at least two negative effects that people have had on the planet Earth.
Heredity and Evolution 26. Recognizing that many living things tend to produce more offspring than their environment can support, and that many of these offspring - those who are weaker or less well adapted - die	26. Does every fish, frog, ant, deer, etc. that is born survive? Why?
27. Identifying mutations as "copying mistakes" in genetic material which bring about abnormalities in the next generation (many of these abnormalities are harmful, but some provide their recipients with new advantages in survival)	27. What are mutations?
(28.) Describing the three key elements in natural selection: -the tendency of each generation to produce more offspring than can survive in the environment -the variety of individuals in each new generation because of the mixing of genetic material in sexual reproduction and mutations -the killing off and death of those who are weakest and least well adapted to the environment [maintained]	28. Describe the process of natural selection.

SIXTH GRADE D, E

(29.) Identifying some current species that are in danger of becoming extinct, and citing the reasons	29. Name at least three animals that are in danger of becoming extinct: what human activities or natural forces are endangering their survival? 
30. Recognizing that current scientific theory postulates that, over a period of 3-1/2 billion years, single-celled life in the water gradually evolved into worms, fish, amphibians, reptiles, birds and mammals, primates, and humans	30. How long ago do most scientists think that life originated on the planet Earth? Through what stages do they think life has evolved?
31. Recognizing that humans have used their intelligence to adapt to many different environments, while many animals are "trapped" in the environment for which their bodies evolved	31. Which living creature on Earth has the ability to survive in the greatest variety of environments? What makes this possible?
E. HUMAN BIOLOGY AND HEALTH	
Anatomy	
(1.) Distinguishing between cells, tissue, organs, and systems, and giving examples of each	1. Give an example in your body of: a cell; a tissue; an organ; and a system.

SIXTH GRADE E

(2.) Adding the endocrine and reproductive systems to the list of major body systems already covered	2. Give a brief description of what each of the following systems does in your body: -skeletal -respiratory -muscular -endocrine -circulatory -reproductive -digestive
(3.) Identifying the major structures of the male and female reproductive system	3. Name the most important parts of both the male and female reproductive systems.
4. Identifying the major structures of the endocrine system	4. Name the most important parts of the endocrine system.
(5.) Identifying the kinds of human blood cells, the other materials in blood (plasma, etc.), and the function of each	5. What are the two kinds of blood cell, and what does each do? What else does blood contain?
(6.) Describing the stages in the human life cycle: egg and sperm, fertilization, zygote, embryo, fetus, newborn, child, adolescent, adult	6. Describe the life of a human being from the very beginning to the end.
(7.) Giving examples of inherited and acquired traits, and of innate and learned behavior [maintained]	7. What are some traits that you inherited from your parents and ancestors? What are some qualities that you have acquired in your lifetime? What are some things that your body does without your having consciously to think about it? What are some things that you've learned in the last few years?
(8.) Describing the structure of the human eye and explaining the function of each part	8. Draw a sketch of a cross-section of the human eye, and explain what each part of the eye does. 

SIXTH GRADE E

Nutrition 9. Distinguishing our physical from our social needs	9. Which of these are <u>physical</u> needs and which are <u>social</u> needs? -water -"elbow room" -food -air -sleep -recreation -love
10. Giving examples of foods in each of the five groups, and identifying which of the first four groups is not represented in a day's meals and snacks: -fresh fruits and vegetables -whole grain breads and cereals -dairy products -meat, eggs, nuts, beans, etc. -"junk foods" - candy, cookies, chips, soft drinks, etc.	10. Give examples of foods in each of the five groups. Now tell which kind of food is missing from this day's food: -fruit, eggs, bacon -Sprite -salad, orange, cookies -potato chips -omelette, salad, fruit cocktail
Health 11. Identifying ways of measuring a person's physical fitness - heartbeat, lung capacity, energy level, reaction time, etc.	11. If you had to decide which of two people was more physically fit, and could not ask them to perform athletically, what information would you want to gather?
12. Identifying the relationships between strenuous physical exercise and a person's cardiovascular efficiency, resistance to disease, and general health	12. Which of these people is least likely to have a heart attack or get sick, and is most likely to feel healthy and strong? -a man who drives his car to work and then sits at a desk all day -a man who works as a telephone operator all day, then takes the bus home and cares for his children -a man who runs ten miles a day in preparation for the Olympics -a man who works as a waiter in a restaurant, walks a mile to his house -a man who jogs a mile every morning before going to his teaching job
13. Identifying the sources of obesity, heart disease, high blood pressure, and other health problems (partly inherited and partly caused by life style)	13. Check all the factors that might cause a person to have a heart attack, have high blood pressure, or be overweight: -having ancestors who had these problems -eating foods high in saturated fats -getting no exercise -watching television

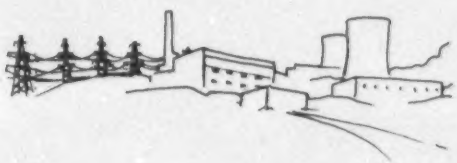
SIXTH GRADE E

(14.) Identifying some common diseases and how people contract them	14. Name at least three common diseases. How do people usually get them?
(15.) Describing various drugs in terms of their effects on the human body	15. What effect does each of these substances have on the human body? -aspirin -penicillin -alcoholic beverages in excess -tobacco (in cigarettes) -coffee -tea -marijuana -cocaine -heroin -amphetamines -LSD -"angel dust"
(16.) Differentiating between ailments that one can treat oneself, and those that require a doctor's care [maintained]	16. Make a list of at least five health problems that you should definitely see a doctor about. Now make a list of problems that it would be safe to treat yourself.
(17.) Identifying indicators of bodily distress, and appropriate action in each case	17. How would you know if a person was having each of these problems, and what could you do to help someone who is? -choking -suffocation -heart attack -stroke -going into shock
(18.) Identifying body temperature well over 98.6 degrees Fahrenheit as an increasingly dangerous sign of illness	18. What conclusions would you draw if a person had each of the following body temperatures? -98.4 degrees -98.6 degrees -99 degrees -100 degrees -103 degrees
(19.) Describing a doctor's routine physical examination - what the doctor looks at (blood pressure, reflexes, heartbeat, lung, eyes, etc., what he or she might find)	19. Explain in detail what a physician does when he or she gives you a routine check-up. What is the reason for each test?

SIXTH GRADE E, F

20. Describing the process by which shots mobilize antibodies and give us immunity to certain diseases	20. How do vaccinations help prevent diseases from making us sick?
Safety 21. Identifying some major safety hazard for this age group, and describing ways of minimizing the risks of each one: -pedestrian accidents -injuries in car accidents -bicycle accidents -fires in buildings (prevention and escape) -tools of various kinds -eye injuries -exposure to toxic substances (e.g., asbestos, mercury, etc.) -sports, especially hockey and football -swimming -etc.	21. Make a list of at least ten ways that children your age are sometimes injured or killed. How can you cut down your risk of being the victim of each one?
F. PHYSICAL SCIENCE **Matter** 1. Knowing the definition of matter - anything that has mass and occupies space - and categorizing matter as either solid, liquid, or gas	1. What is matter? Put these items into the three categories of matter: -oxygen -mercury -wood -gold -sand -glass -water -carbon dioxide -helium -alcohol -iron -oil
2. Recognizing that all matter is made up of tiny particles called atoms, and that an atom consists mostly of empty space, with almost all of the mass concentrated in the tiny nucleus	2. What is the name of the tiny particles that all matter is made of? What do scientists think these tiny particles look like?
3. Describing the structure of an atom, given a description of the atom and the number of protons, neutrons, and electrons (protons and neutrons in the center, electrons whizzing around in orbit)	3. Make a rough drawing of what a hydrogen atom looks like (it has one proton, one neutron, and one electron)

SIXTH GRADE F

4. Identifying the relative size of different levels of matter	4. Put these in order from the smallest to the largest: -a single cell -a grain of salt -an atom -a drop of water -a molecule -an electron
(5.) Recognizing that when most substances are heated, the atoms that they are composed of move around more quickly, making the substance expand (Note: a few substances shrink when heated: rubber, some package films.)	5. How do atoms behave differently when a substance is heated up? What does this do to the overall size of the substance?
6. Recognizing that ice floats because when water freezes, it expands, making it less dense than water	6. Why does ice float in water?
Heat and Energy (7.) Identifying the advantages and disadvantages of forms of energy in common use today	7. List some pluses and minues of each of these energy sources: -oil -gasoline -firewood -solar energy -nuclear energy -wind  Nuclear Power
8. Giving some examples of ways to conserve energy and scarce resources	8. Name at least three ways that your family is conserving (or could conserve) energy.

SIXTH GRADE F

9. Identifying some ways we can get energy from sources other than oil and coal	9. What ways have scientists found to get energy from each of these sources? -the sun -the wind -the Earth's core -the movement of tides
10. Recognizing that in nuclear reactions, some matter is changed into energy	10. What happens to matter in a nuclear reaction?
(11.) Giving examples of the principle that heat moves from a warmer to a cooler place; identifying ways in which heat moves (conduction, convection, and radiation) [maintained]	11. Think of at least two examples in your home of the principle that heat travels from a warmer to a cooler place. Name three different ways it can travel.
Electricity and Magnetism 12. Identifying materials that are natural magnets (iron, nickel, cobalt)	12. Name at least three materials that are natural magnets.
(13.) Recognizing that a wire with electricity passing through it has a magnetic field around it (it is a simple electromagnet), and that putting a wire into a changing magnetic field will generate some electricity in the wire (a simple generator)	13. Describe how you could generate a small amount of electricity using only a magnet and a wire. What principle is involved?
14. Identifying magnetic repulsion and attraction as the basis for an electric motor's operation	14. What basic feature of magnets makes an electric motor work?
(15.) Describing how electromagnets work in bells, buzzers, telephones, electric motors, etc.	15. When you push a doorbell button, what makes the bell, buzzer, or chime work? Make a rough sketch to illustrate.
(16.) Recognizing that current electricity consists of a flow of electrons along a path; identifying materials that conduct electricity well (conductors), and materials that do not (resistors and insulators)	16. What moves through a wire carrying electricity? What are some of the <u>best</u> substances to make electric wires from? Name some substances that do <u>not</u> conduct electricity?

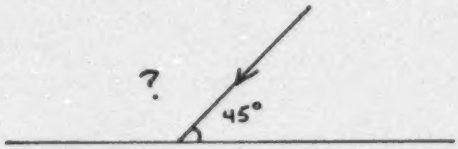
SIXTH GRADE F

17. Describing how electrical energy is converted to heat energy (being passed through a resistor) and into mechanical energy (in an electric motor)	17. In your home, what are two examples of electrical energy being turned into heat energy? Into mechanical energy? How does each conversion work?
18. Describing the purpose of fuses and circuit breakers	18. Why are fuses and circuit breakers so important in houses and other buildings?
Mechanics 19. Identifying compound machines at work in the city around us, and describing which simple machines are at work in each	19. Give at least three examples of a compound machine. List the simple machines (lever, wheel and axle, screw, inclined plane, wedge, pulley) contained in each compound machine.
20. Distinguishing between the three classes of levers (first, second, and third), and giving an example of each, accompanied by a schematic drawing showing the fulcrum, load-arm, effort-arm, etc. (crowbar, wheelbarrow, fishing rod)	20. Sketch a first class, second class, and third class level, and label the fulcrum, load, load arm, effort, and effort arm. Give at least one everyday example of each kind of lever.
21. Calculating a machine's mechanical advantage (the number of times it multiplies a force) and estimating which of a series of simple machines has the greatest mechanical advantage [this follows up on the previous grade's objectives of identifying the key variables affecting the efficiency of each simple machine]	21. A man pulls down on a pulley with a force of 20 pounds, and lifts a weight of 60 pounds. What is the mechanical advantage of the pulley system he is using? Which of these three levers would lift the weight with the least effort?
22. Defining the Earth's gravity as the force that pulls all matter down toward the center of the planet, and recognizing that the greater an object's mass, the more powerful the gravitational force on it	22. What is gravity? On what kinds of objects does gravity exert the strongest pull?
23. Defining friction, distinguishing between sliding and rolling friction, and identifying ways of reducing friction in various situations	23. What is friction? Give an example of sliding and rolling friction. Name some ways that people can reduce friction.

SIXTH GRADE F

24. Identifying the factors that affect the period of a simple pendulum	24. How can you make a pendulum's back and forth swing take longer? How can you make it swing back and forth more quickly?
Sound 25. Recognizing that sound is a form of energy that is produced by a vibrating object, that it is transmitted from one place to another by making some intervening substance (e.g., air, wood) vibrate, and that we detect sounds when our eardrums vibrate	25. Pretend you are watching a man play the guitar. How does the sound of the guitar reach you? Trace the sound from the man's finger plucking the string to your brain "hearing" it.
26. Recognizing that sound cannot travel through a vacuum, but only through an intervening medium	26. Why can't astronauts floating in space hear each other talking (unless they use their radios)?
27. Contrasting the <u>loudness</u> of a sound (which increases with the amplitude of the sound waves) with the <u>pitch</u> of a sound (which increases with the frequency of vibrations)	27. Give an example of: -a loud sound -a soft sound -a high-pitched sound -a low-pitched sound
28. Describing ways that sound waves can be reflected (echoed) and absorbed, and naming materials which reflect and absorb sound	28. In what kind of room does your voice echo? In what kind of room are sounds "soaked up" and not echoed? What makes the diffence?
29. Recognizing that sound travels more slowly than light (i.e., we hear distant events after we see them), and giving examples of this in everyday life	29. Which travels more quickly, sound or light? Give two examples that prove that your answer is correct.
Light 30. Identifying the following properties of light: -it travels in a straight line -it reflects off a mirror (at an angle opposite to the angle at which it entered the mirror) -it is refracted (bent) as it passes through glass or water -it is absorbed by dark, non-shiny surfaces (and converted to heat energy) -it can be focused or spread out by being passed through a lens	30. Tell how light behaves when it: -shines out of a flashlight -shines into a mirror -shines through a thick piece of glass or plastic or through water -shines through a lens -shines on a dark surface

SIXTH GRADE F, G

31. Identifying the angle at which a ray of light will be reflected from a plane mirror (the angle of incidence equals the angle of reflection)	31. If a beam of light shines onto a mirror at a 45 degree angle, at what angle will it leave the mirror? 
32. Describing what happens when a beam of light enters or leaves a transparent material at an angle (it is refracted)	32. What happens when a beam or light shines through a thick piece of glass or plastic? Through water?
33. Naming some common uses of plane mirrors (periscopes) and curved mirrors (telescopes, binoculars)	33. What are some everyday uses of plane mirrors? Of curved mirrors and lenses?
34. Describing what happens to white light when it passes through a prism (it is refracted into a spectrum of colored light)	34. What happens to white light when it passes through a prism?
(35.) Identifying the sequence of colors in the spectrum (red, orange, yellow, green, blue, indigo, violet) [the colors and their sequence can be remembered by the acronym ROYGBIV, pronounced ROY-GEE-BIV.]	35. What are the seven colors in the spectrum? Name them in order.
G. EARTH SCIENCE	
Weather	
1. Explaining how the uneven heating of the Earth's surface by the sun leads to winds and weather conditions [maintained]	1. What is the main cause of winds and weather?
(2.) Recognizing that water heats up and cools down more slowly than land, and explaining the effect that this phenomenon has on the weather in a coastal city like Boston	2. Why does Boston often have a breeze blowing onshore during the day and offshore in the evening? Explain the reasons in detail.

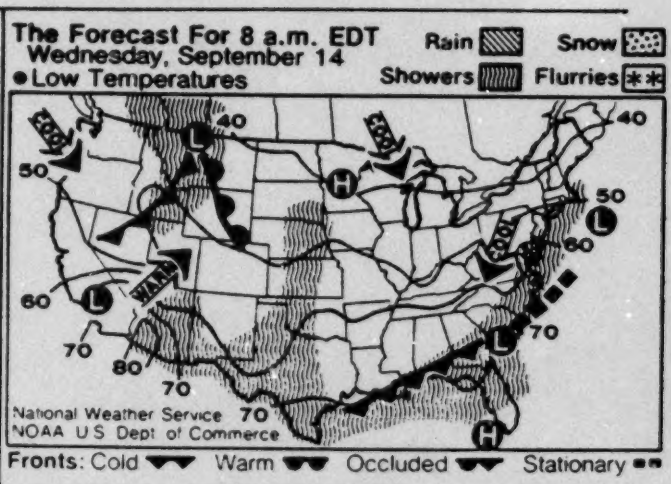
SIXTH GRADE G

(3.) Distinguishing between weather and climate by contrasting the climate of two cities in different parts of the world on a day when they are having exactly the same kind of weather	3. On a particular day, Boston and Miami, Florida had exactly the same weather: temperature 70 degrees, humidity 65 percent, barometric pressure 29.9 and rising, cloudless skies. Does this mean the two cities have the same climate? Explain.
(4.) Listing the factors that determine the type of climate and weather of a particular place: -latitude (distance from the equator) -altitude (height above sea level) -large bodies of water nearby -mountains barriers nearby -prevailing winds	4. Name at least three factors that make the climate different in Denver, Colorado than it is here in Boston.
5. Identifying the general direction of the weather in the U.S. as west to east, with many of the big storms that hit Boston moving northeast up the Atlantic coast, or out of the Ohio River Valley and the Gulf states	5. In what direction does the weather usually move across the United States? When we get a major storm in Boston, where has it usually been just before it reaches us?
6. Identifying some ways that people have altered the weather (cities warmer than suburbs and countryside; seeding of clouds; pollution; etc.)	6. Can people change the weather? If so, how?
7. Describing how the water cycle operates [maintained]	7. What is the water cycle? How does it work?
8. Identifying the different types of clouds (cumulus, cumulonimbus, cirrus, stratus) and the weather that they generally bring with them [maintained]	8. Name at least three different kinds of clouds. What kind of weather does each kind usually bring.
(9.) Describing the conditions that lead to various forms of precipitation	9. What weather conditions cause it to rain? To snow? To hail?
(10.) Describing the characteristics of some short-lived, violent weather phenomena	10. Describe what it is like to be caught in a: -thunderstorm -blizzard -tornado

SIXTH GRADE G

11. Recognizing that the weight of the air above us in the atmosphere creates an atmospheric pressure of about 15 pounds per square inch	11. What is atmospheric pressure? What causes it? About how many pounds per square inch is the pressure on your skin right now?
(12.) Recognizing that genearlly, low barometric pressure is associated with poor weather, high barometric pressure with good weather	12. What kind of weather usually comes with high barometric pressure? With low pressure?
(13.) Identifying the major layers of the atmosphere and the approximate depth of each (the troposphere, 7 1/2 miles above the ground; the stratosphere, from 7 1/2 to 50 miles; and the ionosphere, from 50 to 200 miles)	13. What are the first three layers of the atmosphere? About how deep is each layer?
(14.) Identifying common weather instruments and what each measures: -anemometer; measuring wind speed -thermometer; measuring temperature -barometer; measuring atmospheric pressure -wind vane; telling wind direction -hygrometer; measuring humidity -rain gauge	14. Name six common weather instruments, and tell which one measures the temperature, atmospheric pressure, humidity, wind speed, wind direction, and amount of rain.
15. Making a prediction for the weather tomorrow, given several readings from weather instruments	15. If today's temperature is 26 degrees, the barometric pressure is 29.2 and falling, skies are clear, and the wind is blowing strongly out of the northeast, what would you predict tomorrow's weather will be?
(16.) Identifying the meaning of commonly used symbols on a weather map (frontal systems, low and high pressure areas, barometric pressure, etc.), and using them to get information from a newspaper weather map	16. According to the weather map below, what kind of weather is Boston going to have on September 14? What is the temperature in southern Texas? What kind of weather is moving into Oregon? In what two parts of the country is there a high pressure area?

SIXTH GRADE G

	
17. Recognizing basic information on a satellite weather map (frontal system, hurricane, etc.)	17. On a satellite weather photo, what does a large white pinwheel of clouds mean?
Geology 18. Recognizing that the inner core of the Earth is very hot, and recognizing that tectonic plates are moving around very slowly as they "float" on this molten interior	18. How can the huge plates on the surface of our planet move around? What makes this possible?
19. Identifying some of the major changes in the Earth's continents that have been brought about by plate tectonics over millions of years (the Atlantic Ocean opening up, the Indian Ocean plate tucking under Asia and forming the Himalayas, etc.)	19. Give an example of an ocean and a mountain range that have been formed by the movement of tectonic plates over millions of years.
20. Recognizing that faults in the Earth's crust are the primary cause of earthquakes, and that earthquakes are much more frequent along fault lines (as in southern California)	20. In what parts of the world are severe earthquakes most common? Why?
21. Recognizing that the Earth is undergoing constant change because of volcanic eruptions, folding, faulting, movement of continental plates, weathering, erosion, etc.	21. If you could go into suspended animation and wake up 50 million years from now, the surface of the Earth would look quite different than it does now. Name at least six <u>natural</u> (not human) forces that would have been responsible for the changes.

SIXTH GRADE G

22. Describing how igneous, sedimentary, and metamorphic rocks are formed, identifying their main characteristics, and giving examples of each	22. How are the three types of rock formed over the years? Give an example of each.
23. Describing the destructive effect of topsoil erosion, and identifying specific soil conservation practices that reduce the loss of topsoil (crop rotation, terracing, contour farming, and planting on sloped surfaces)	23. What problems are caused by topsoil erosion? What are some steps that people have taken to control erosion?
24. Identifying minerals as the basic components of rocks, and naming some mineral resources (iron, silver, diamonds, etc.)	24. What are all rocks composed of? Name at least ten valuable resources that people get from rocks.
25. Identifying some major eras of geologic time (Precambrian, Cambrian, Mesozoic, Canozoic)	25. Name at least three important eras and periods of geologic time.
26. Identifying fossils in the deepest strata of the Earth as being the oldest (except where inversions have tipped the normal chronology upside down)	26. If you found one fossil ten feet underground and another fossil fifteen feet down, which would probably be older? When would this not be true?
27. Recognizing that soft-bodied animals are rarely preserved as fossils, while vertebrates and hard-shelled invertebrates have left plentiful fossils	27. Why are there so few fossils of soft-bodied animals from millions of years ago, and so many fossils of hard-shelled invertebrates and vertebrates?
28. Identifying the four kinds of fossils: -hardened prints or impressions -entire preserved bodies or parts of them -casts of plants and animals -petrified remains	28. Name four kinds of fossils.
29. Comparing the features of the ocean floor with those of dry land	29. If you took all the water out of the Atlantic Ocean, how would appearance of the ocean floor be different from that of dry land?

SIXTH GRADE G, H

30. Naming some of the resources of the ocean floor (minerals and animal life)	30. Name at least five important resources that people get from the ocean.
31. Identifying some natural resources that are becoming scarce, and measures that are being taken to conserve them	31. Name at least three natural resources that are running low on the planet Earth. What is being done to conserve each one?
(32.) Recognizing that minerals are a non-renewable resource, and that the supply of some commonly used minerals is running low	32. Are minerals a renewable or a non-renewable resource? Name some minerals that are close to being used up.
(33.) Describing ways that humans have damaged the environment (strip mines, pollution, deforestation, etc.) and the steps that are being taken to remedy some of this damage	33. Name at least three ways that people have harmed the environment around them. What is being done to prevent this kind of damage in the future, and undo the damage that has already been done?
H. ASTRONOMY	
Origins of the Universe	
(1.) Describing the major features of the latest scientific theory of the origins of the universe: -the "Big Bang"; -formation of hydrogen and helium atoms; -formation of stars; -explosion of stars (supernovas) creating other kinds of atoms; -formation of stars with planets	1. How do most scientists think the universe was formed? What steps led up to the formation of the planet Earth?
2. Describing the contributions of some major astronomers to the field	2. What did Ptolemy, Kepler, and Galileo contribute to the science of astronomy?
The Solar System and Beyond	
3. Describing how Copernicus's theory changed the way people viewed the universe (the Earth was no longer the center)	3. Before Copernicus, what did people think was the center of the universe? How did Copernicus change that?

SIXTH GRADE H

4. Recognizing that the sun is one of many billions of stars in the Milky Way galaxy, and that our galaxy is only one of many more billions of galaxies in the universe, which in turn is larger than any scientific means of measurement	4. What is the place of our solar system in the universe? Put our solar system in perspective.
5. Describing the difference between the Earth's environment and that of outer space (air, water, warmth, food, etc.), and identifying the life support systems that astronauts have to carry when they travel outside the Earth's atmosphere	5. What does an astronaut have to bring along to survive in outer space? Why?
6. Naming the planets of our solar system in order from the sun - Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Pluto, and Neptune [until 1999, when Pluto will be outermost again]	6. List the nine known planets in our solar system in order from the sun.
(7.) Identifying those planets which (as far as we know) have rings (Jupiter, Saturn, and Uranus)	7. Which three planets have rings?
(8.) Recognizing that gravity is a force throughout the universe, and that it pulls all bodies of matter toward each other	8. How does gravity affect a satellite travelling through outer space?
(9.) Identifying the forces that keep the planets in orbit around the sun (the sun's gravity and the planets' inertia)	9. What two forces keep the Earth and the other planets in orbit around the sun?
10. Recognizing that meteorites are objects that have fallen to the Earth from outer space	10. What are meteorites?
(11.) Explaining what happens in a lunar eclipse (when the Earth comes between the sun and the moon and casts its shadow on the moon)	11. What is a lunar eclipse? Make a sketch to illustrate how it works.

SIXTH GRADE H

(12.) Explaining what happens in a solar eclipse (when the moon comes between the Earth and the sun and temporarily blots out our sunlight)	12. What happens in a solar eclipse? Make a sketch to illustrate.
13. Identifying the reasons that solar and lunar eclipses are so rare (the moon's orbit is inclined about 5 degrees from that of the Earth, so the sun, moon, and Earth are rarely lined up)	13. Why don't eclipses happen more often?
14. Identifying the reason for the moon's phases (the sun shining on the moon from different angles)	14. Why does the moon go though different phases every month?
15. Identifying waxing and waning moons	15. Which of these is a waxing and which is a waning moon?
16. Describing how the moon, sun, and Earth influence our tides	16. What causes the ocean's tides?
17. Identifying the forces that come into play when we send rockets into space (gravity, inertia, friction, etc.)	17. Name the forces that are acting on the space shuttle as it is launched into space and enters its orbit.
18. Explaining why a shadow cast by the sun through a window at the same time of day is in a slightly different position every day	18. The sun coming through a window at exactly 10 o'clock in the morning casts a shadow on the floor of Roger's bedroom. Roger marks the exact position of the shadow with a pencil. A week later, at exactly 10 o'clock in the morning, he marks the shadow again, but finds it is not in the same place. How would you explain to Roger why this has happened (he is in the fifth grade)?
19. Explaining the reasons for the changing seasons [see Grades Four and Five for more detailed objectives leading to this one]	19. Why are the four seasons so different in Boston?

SIXTH GRADE H, I

20. Recognizing the Tropic of Cancer as the imaginary line on the Earth where the sun is directly overhead at noon on June 21, and the Tropic of Capricorn as the line where the sun is directly overhead at noon on December 21	20. What is the meaning of the Tropic of Cancer and the Tropic of Capricorn on globes and maps of the Earth?
21. Identifying the tools of the astronomer - telescope, photography, radio telescope	21. Name at least three pieces of equipment that astronomers use to gather information about the stars, planets, and outer space.
22. Describing a light year as the distance that light can travel in a year (about six trillion miles), and explaining why light years rather than miles are used by astronomers to talk about distances in space	22. What is a light year? Why do astronomers measure distances in light years?
I. SCIENCE READING	
(1.) Reading at least three of the science books or magazines listed at the end of the eighth grade objectives, either as part of the individual project (objective A-2), or as a separate activity	1. Teacher observation and record keeping

SEVENTH GRADE

A. SCIENCE EXPERIENCES	
(1.) Carrying out and reporting on at least one hands-on science experiment or project, working individually or in small groups. The topics of the experience should be chosen by each student, drawing on the content for this grade level (see sections C - H) or other topics of interest. The experience is open-ended in terms of content, but should incorporate as many of the following general science processes as possible: a. Stating what you want to find out in clear and precise terms b. Planning the project or experiment, deciding what equipment and materials are needed and gathering them, and deciding whether a set of control observations is required c. Stating a hypothesis (an educated guess) about what might happen d. Carrying out the experiment or project, controlling and systematically changing variables e. Observing and describing what happened, using measurement instruments to get precise readings where necessary; testing the hypothesis and making predictions f. Keeping records of data gathered g. Sorting, comparing, and classifying the information gathered, looking for patterns and regularities h. Analyzing the data, and arriving at logical conclusions i. Presenting the conclusions in oral, written, or graphic form	1. Teacher observation: By the end of the year, has the student completed and reported on at least one direct science experience which includes most of the science processes and skills? Some possible experiences: - systematically observing changes in plants and animals over time - systematically observing changes in the weather over time - performing experiments with plants and different forms of light and nutrients - making systematic observations of an aquarium or terrarium - performing a dissection of an animal - repairing a household appliance by using the manual or other source of information - building or developing something, e.g., a computer game, amplifier, radio, electronic device, etc.
(2.) Using books (see section I), interviewing, field trips, or other experiences to find out a great deal about one topic, and presenting a written report on that topic	2. Teacher observation: Has the student chosen a topic, made a thorough investigation of it, and presented a written report? Some possible topics: - telescopes - satellites - supernovae - galaxies - cyclotrons, accelerators - plasma physics - DNA research

SEVENTH GRADE B

B. SCIENCE SKILLS AND PROCESSES	
Observing	
(1.) Observing carefully: noticing such details as size, shape, color, texture, weight, taste, smell, position, time taken, etc.	1-14 These skills and processes should be applied and assessed in the Science Experiences, Life Science, Human Biology and Health, Physical Science, Earth Science, and Astronomy sections. Specific right-hand column examples are not given in order to encourage the application of the skills to all content areas. The substantial overlap of these skills with those in the mathemtaics curriculum document makes it possible to teach many science and mathematics skills simultaneously.
(2.) Using a microscope and mounting slides correctly	
3. Recognizing ways in which different people can observe the same phenomena differently, and identifying ways of making measurements objectively	
Measuring	
(4.) Identifying the appropriate measuring instrument and unit of measurement for a task [Correlation with Math objectives]	
(5.) Measuring length in English and metric units [Correlation with Math objectives]	
(6.) Measuring weight in English and metric units [Correlation with Math objectives]	
(7.) Measuring time to any fraction of a second, using a stopwatch [Correlation with Math objectives]	
(8.) Measuring temperature in degrees Fahrenheit and Celsius [Correlation with Math objectives]	
9. Measuring volume in English and metric units [Correlation with Math objectives]	
(10.) Measuring angles using a protractor [Correlation with Math objectives]	

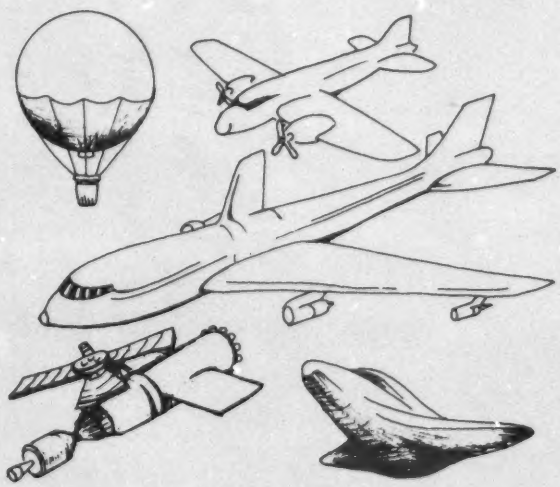
SEVENTH GRADE B

(11.) Interpolating readings on measurement instruments (i.e., estimating readings where markings are not given) [Correlation with Math objectives]	
(12.) Estimating length, weight, temperature, time, and volume where approximate measurements are adequate [Correlation with Math objectives]	
Classifying (13.) Organizing and categorizing objects and information	
Recording (14.) Recording information in the form of sketches, graphs, charts, tables, and writing	
Using Equipment (15.) Using and maintaining laboratory equipment, and identifying safety hazards of some items	15. Teacher observation
Scientific Method (16.) Identifying and distinguishing between major aspects of the scientific method in experiments	16. Gloria wanted to find out which of two kinds of oil (Brand X or Brand Y) was better for her bicycle, so she carried out the following experiment. She bought three identical toy cars. Then she oiled the axle of the first car with Brand X and second car with Brand Y, and left the third car without oil. She guessed that the two oiled cars would roll more easily than the car with no oil, and that Brand Y would work better than Brand X (because she had seen advertisements for Brand Y). Then she started all three cars rolling down the sidewalk at the same time. She saw that the first car with Brand X went fastest. She repeated the experiment ten times, and found that seven out of the ten times, the first car reached the bottom of the hill first. She decided oil had a definite effect on how well the cars rolled, and that Brand X was the best oil for her bicycle.

SEVENTH GRADE B, C

	In this experiment, what were the: -assumptions -variables -control -hypothesis -prediction -observations -inference -conclusion
(17.) Identifying other key factors in obtaining reliable results from scientific work: -a large enough sample -repeated trials -telling significant from insignificant data	17. What are three important things that scientists need to be confident about in the results of an experiment?
(18.) Relating at least one story of how a well-known scientific discovery was made, describing the factors that contributed to its success (persistence, methodology, cooperation, luck, etc.)	18. Tell about how at least one major scientific discovery was made. How important was each of the following factors? -luck -hard work -cooperating with other scientists -courage -persistence
(19.) Identifying and describing at least one story of a major scientific fraud, and telling how it was uncovered; some possible examples: -Piltdown man -Cuvier hoax -Leisenkovism -Cardiff giant -Midwife toad -Cyril Burt -William Darsee	19. Tell about at least one scientific fraud - a situation where a scientist made up or falsified data and tricked people into believing it was accurate work. How was the fraud discovered?
C. SCIENCE AND SOCIETY	
(1.) Distinguishing between science and technology ("pure" versus "applied") and giving examples of each	1. What is the difference between science and technology? Give three examples of each.

SEVENTH GRADE C

(2.) Identifying and describing the impact of at least three scientific/technological advances of the past (e.g., the lighter- than-air balloon, the conquest of malaria, the development of steel, etc.)	2. Name at least three important scientific discoveries or inventions made before 1900, and tell what effect they had on human civilization.
(3.) Recognizing that human population growth has resulted from medical and other advances that prolong life, decrease infant mortality, and eliminate diseases	3. The human population of the world is growing much faster now than it did in the time of Columbus. Why?
(4.) Identifying and briefly describing the impact of at least three recent scientific/technological advances (e.g., laser technology, space flight, DNA research, gene splicing, computer technology, databanks, robotics, etc.)	4. Name at least three important scientific discoveries or inventions made since 1900, and tell about the effect they have had on the world.
5. Identifying the <u>sequence</u> of major scientific/technological advances	5. Number these in the order in which they took place: -first satellite launched -first automobile -first wheeled vehicles -first human in space -mass production of automobiles -first airplanes -first steam engine 

SEVENTH GRADE C

(6.) Recognizing how scientific work is influenced by the beliefs and traditions of each era (e.g., Darwin's hesitation in publishing his theory of evolution), giving examples	6. Give an example of how scientists are affected by what people of their time believe.
(7.) Identifying the world's major problems (population growth, hunger, energy shortages, nuclear stand-off, economic disparities, etc.), and describing the role of science and technology in dealing with them	7. What do you think are the four most pressing problems the world faces today? Can science and technology help solve these problems? Explain.
(8.) Describing at least one major scientific or technological issue that has been in the news this current school year (examples from previous years might include Three Mile Island, the space shuttle, toxic waste dumps, etc.)	8. Tell about at least one science-related story that has been reported on TV or in the newspapers this year. Why was it important enough to make news?
(9.) Identifying several examples of "non-science," and outlining the debate between proponents and scientific skeptics; some possible topics: -parapsychology -psychokinesis -E.S.P. -Atlantis -Bermuda Triangle -U.F.O.s -dowsing rods -pyramid power -astrology -tarrot cards	9. Give at least three examples of strong beliefs that some people hold that are not backed up by scientific evidence. Tell both sides of the debate between scientists and people who hold each set of beliefs. Is it important that these beliefs are not scientifically provable?
(10.) Describing the contributions and some biographical details about a few major scientists, including women and minorities	10. Choose at least three important scientists (make sure your list includes a male/female and racial/ethnic mix), and tell about the life and work of each. [See list in appendix.]

SEVENTH GRADE C, D, E

(11.) Identifying the pros and cons of an ethical issue in science and technology, where what is technically possible conflicts with some people's beliefs or interests, e.g.: -pollution control versus the loss of jobs it may cause -nuclear power plants versus the possible health risks they produce -DNA research versus the fear of genetic meddling -laboratory experiments on animals -the cost of space travel versus the needs of starving people on Earth -birth control versus the religious beliefs of some	11. Choose one scientific/technological issue about which there is a heated debate going on. Explain both sides of the argument.
(12.) Identifying at least ten science-related vocations and avocations, and describing the education and other training necessary to gain access to each	12. What are at least ten hobbies and jobs that involve science and technology? What kind of education and training would you need to get each of the jobs?
D. LIFE SCIENCE [No objectives at this level; see Grade Eight, which focuses on Life Science]	
E. HUMAN BIOLOGY AND HEALTH **Anatomy** (1.) Giving examples of cells, tissue, organs, and systems in the human body, and ranking them in order of complexity	1. Put these in order from the smallest and simplest to the largest and most complex: -an organ -a cell -a system -a tissue Give an example of each in your body.
(2.) Adding the metabolic and excretory systems to the list of body systems already covered, and describing the basic function of all the systems	2. Briefly tell what each of these systems does in your body, using diagrams to illustrate where necessary: -metabolic -respiratory -excretory -digestive -muscular -reproductive -skeletal -endocrine -circulatory

SEVENTH GRADE E

3. Describing the structure of the endocrine system, and the relationships between endocrine secretions, growth patterns, and teenage development	3. How does the endocrine system work? Why does it have a particular impact on people in their early teens?
4. Identifying the major structures of the digestive system, including the enzymes and the material absorbed into the bloodstream after digestion is complete	4. How does the digestive system work? Describe all the stages between the time food enters your mouth to the time nutrients are absorbed and used by your body.
5. Recognizing that food is burned by the body to produce the energy needed to run the body	5. How does the body turn food into the energy and heat it needs to be active?
6. Recognizing that food and oxygen combine in the cells to release energy, producing carbon dioxide as a waste product	6. Describe the chemical reaction that takes place in your digestive system between food and oxygen. What are the waste products?
7. Describing the structure of the circulatory system, how it is controlled, and the route taken by the blood as it is pumped around the body	7. How does the circulatory system work? Describe the route taken by the blood, oxygen, and carbon dioxide.
8. Identifyirg the main constituents of blood and the major blood groups	8. What is blood made of? What blood group do you belong to? What are the other major blood groups?
9. Identifying the major structures of the excretory system	9. How does the excretory system work? Describe how the body gets rid of waste products.
10. Identifying three types of muscles and describing the structure and function of each	10. Name three kinds of muscle in your body. Tell what each one looks like (use a sketch) and how each one works.
11. Identifying the functions of the major parts of the central nervous system	11. How does your central nervous system work? Explain what each part does.
12. Describing the stages of the human life cycle, from egg and sperm through adulthood [maintained]	12. Tell briefly about each stage that a person goes through from the very beginning to the end of his or her life.

SEVENTH GRADE E

(13.) Giving examples of inherited and acquired traits, of innate and learned behavior [maintained]	13. Name at least three: -inherited traits -acquired traits -innate behaviors -learned behaviors
Health and Nutrition (14.) Identifying specific conditions that detract from good physical and psychological health	14. Make a list of some things in your home, school, or city, and things you do, that make you less healthy.
(15.) Categorizing foods in the five groups, and identifying which of the first four is not represented in a day's meals and snacks: -fresh fruits and vegetables -whole grain breads and cereals -dairy products -meat, eggs, nuts, beans, etc. -"junk foods" - candy, cookies, soft drinks, chips, etc. [maintained]	15. Which of the first four food groups is not represented in this day's meals and snacks? -potato chips, Tab -yogurt -cheeseburger, French fries, Coke -steak, baked potato, butter, sour cream
(16.) Identifying some effects of an inactive lifestyle on human health	16. What difference does it make whether a person exercises a lot or spends most of the time sitting down?
(17.) Identifying the effects of obesity and high blood pressure on human health	17. What risks are greater for people who have high blood pressure and are overweight?
(18.) Identifying some major hereditary diseases (sickle cell anemia, hemophilia, diabetes, etc.) and how they are currently treated	18. Name at least three diseases that some people inherit from their ancestors. How can doctors help victims of each disease?
(19.) Identifying some deficiency diseases and how they are caused and prevented	19. Name at least two deficiency diseases. Why do some people get them, and how can they be prevented?
(20.) Describing the symptoms and effects of some major communicable diseases, including those that are sexually transmitted, and describing how they are treated and how they can be avoided	20. Name at least five diseases that people can catch from other people (communicable diseases), including STD's. For each disease, describe the symptoms, the effects on the body, how people catch them, how doctors treat them, and how they can be avoided.

SEVENTH GRADE E

(21.) Identifying the effects of some commonly used drugs, and the factors that lead people to abuse them	21. What effects does each of these drugs have on the human body? Why do people use each drug? -alcohol -coffee -tobacco -heroin -amphetamines -heroin -LSD -"angel dust"
(22.) Identifying ailments that one can treat oneself, and those that require a doctor's care [maintained]	22. Make a list of physical problems you should definitely see a doctor about. Now make a list of problems that it would be safe to treat at home.
(23.) Recognizing that inoculations mobilize antibodies which can fight off various diseases	23. How do inoculations help prevent diseases?
(24.) Describing procedures that a person can use to monitor his or her general health (heart-rate, reflexes, temperature, etc.), and the way in which a doctor's equipment can provide additional information (blood pressure, eye examination, listening to lungs, etc.)	24. Name at least three ways that you can check to see if your body is healthy. What are some things that a doctor can check to get more information?
(25.) Recognizing indications of bodily distress, and describing appropriate action to take in each case [maintained]	25. Describe the way each of these crises affects a person, and what you could do to help a victim: -choking -suffocation -heart attack -stroke -going into shock
Safety (26.) Describing the recommended steps for escaping from a burning building: -leave immediately -crawl to avoid smoke -breathe through a wet handkerchief -use stairs, not elevators [maintained]	26. If you were on the fifth floor of a large department store when a major fire broke out, what would it be important for you to remember?

SEVENTH GRADE E, F

(27.) Identifying some major safety hazards for this age group, and describing ways of minimizing the risks of each one: -pedestrian accidents -injuries in automobile accidents -bicycle accidents -burning buildings (see above) -tools of various kinds -eye injuries -swimming -sports, especially contact sports	27. What are some ways that people your age are injured and killed? Make a list of at least ten, and after each one write some ways you might reduce your own risk of being a victim.
28. Identifying substances which have been proven to be, or are suspected of being, carcinogenic or causes of birth defects (e.g., asbestos, lead, DES, tobacco, cyclamates, etc.), and listing places where each is found	28. Name at least three substances that are thought to cause cancer, birth defects, and other serious health problems.
F. PHYSICAL SCIENCE **Matter** (1.) Identifying the general properties of matter (volume and mass) and identifying examples and non-examples	1. How can you tell whether something is matter or non-matter? Give some examples of each.
(2.) Identifying the three states in which matter commonly exists - solid, liquid, and gas [A fourth state is plasma]	2. What are the three states of matter?
(3.) Recognizing that the weight of an object changes as gravity changes, but its mass never changes	3. If you travelled to the moon, would your weight be the same? Would your mass be the same? Explain.
4. Naming at least one place in the solar system where a person's weight would be greater than it is on Earth	4. On what planets would your weight be greater than it is on Earth?
(5.) Describing changes of matter from one phase to another, and identifying the energy input or output that accompanies such changes (e.g., water to water vapor; heat or solar radiation)	5. Give at least three examples of matter being changed from one state to another. What role does energy play any time matter changes its state?

SEVENTH GRADE F

(6.) Recognizing that a substance is matter that has its own special properties	6. What is a substance?
(7.) Describing a substance in terms of its physical and chemical properties	7. Choose one substance and tell about its properties: -melting point -freezing point -boiling point -color -density -hardness -acidity -texture -taste -odor -solubility -malleability
(8.) Defining atoms as the small particles that compose all matter, and describing the probable appearance of the nucleus, protons, neutrons, and electrons, using a sketch	8. What are atoms? What do scientists think they look like? Make a sketch of a helium atom.
(9.) Labeling the nucleus, protons, neutrons, electrons, and electron shells in a schematic drawing of a helium atom	9. In the sketch you made of a helium atom, label the nucleus, protons, neutrons, electrons, and electron shell.
(10.) Making a drawing of a single atom of any element numbered 1 to 20 on the Periodic Table of the Elements showing: the number of neutrons and protons, and the number of electrons in each electron shell	10. Make a sketch of a carbon atom (its atomic number is 6)
(11.) Identifying the electrical charge of neutrons (neutral), protons (positive), and electrons (negative)	11. What is the electrical charge of each part of an atom?
12. Describing the role of some of the major scientists involved in the investigating the nature of matter	12. Tell briefly about the contribution of at least two of the following: -Democritus -John Dalton -J.J. Thomsom -Lord Rutherford -Neils Bohr -Mendeleev -Einstein -Oppenheimer -E.O. Lawrence

SEVENTH GRADE F

(13.) Defining elements as the basic building blocks of matter, and identifying at least ten common elements and their symbols	13. What are elements? Give at least ten examples, and write their chemical symbols.
(14.) Defining an <u>atom</u> as the smallest particle of an element, and a <u>molecule</u> as the smallest particle of a compound	14. What is the relationship between atoms and elements, and between molecules and compounds?
(15.) Distinguishing between an <u>element</u> (only one kind of atom), a <u>compound</u> (two or more elements combined chemically), and a <u>mixture</u> (two or more elements and/or compounds mixed together without chemically combining)	15. What is the difference between an element and a compound, and between a compound and a mixture?
(16.) Identifying examples of things that are made of one, two, and three or more elements, and naming the elements	16. How many elements does each of these have: one, two, or more than two? -gold -silver -iron -air -salt -vinegar -a diamond -water Name the elements in each.
17. Determining the number of protons, neutrons, and electrons in a single atom of any element, given the atomic number and the atomic weight of the element	17. The atomic number of silicon is 14. How many protons, neutrons, and electrons does an atom of silicon have?
18. Reading the key for each element and distinguishing between the symbol, atomic number, and mass number (atomic weight)	18. Explain each letter and number of this entry in the Periodic Table: 26 Fe Iron 55.847
(19.) Identifying groups (vertical columns) and periods (horizontal rows) on the Periodic Table	19. How can you identify a group of elements on the Periodic Table? How can you identify periods?
20. Identifying the common characteristics of the elements in each group	20. What do the elements in the first group (1a) have in common?

SEVENTH GRADE F

21. Identifying the common characteristics of all the elements in the same period	21. What are the common characteristics of elements in period III of the table?
22. Identifying where most of the metals, non-metals, and inert elements can be found on the Table	22. Where are most of the metals on the Periodic Table? Non-metals? Inert elements?
23. Identifying isotopes as atoms of the same element which have the same atomic number and the same chemical properties, but have different atomic weights	23. What are isotopes? Give an example.
24. Recognizing that some atoms are radioactive and release energy, and identifying some examples	24. What does it mean for an atom to be radioactive? Give at least two examples.
25. Recognizing that radioactive decay rates (half-lives) have been used to date fossils, artifacts, etc.	25. How can the radioactive decay rates of some elements be used by archeologists?
26. Recognizing that atomic energy results from the conversion of nuclear mass into energy, and giving examples of its use (power plants, bombs)	26. What happens when matter is converted to energy? How has this principle been applied in the last 40 years?
27. Distinguishing between weight and mass, and calculating the density of a substance, given basic data	27. What is the difference between the weight and the mass of something? If a substance weighs 200 grams and has a volume of 66 cubic centimeters, what is its density?
28. Identifying the peculiar behavior of water near its freezing point, and contrasting its properties to those of most other substances	28. What changes does water go through as its temperature is lowered through 32 degrees Fahrenheit? Is this typical of other substances? How so?
Combinations 29. Distinguishing between <u>physical</u> changes, in which only physical properties are altered (e.g., ice melting, sugar dissolving), and <u>chemical</u> changes, where the way atoms are arranged into molecules is changed (e.g., iron rusting)	29. Give some examples of physical and chemical changes. What is the important difference between them?

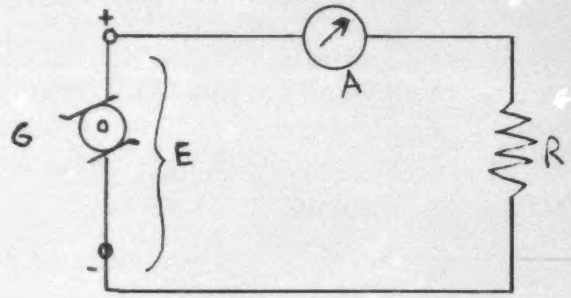
SEVENTH GRADE F

(30.) Recognizing that in chemical or physical changes, the total amount of matter remains the same, whereas in a nuclear reaction, matter is converted into large amounts of energy	30. In which of these types of change is the amount of matter reduced? -chemical -physical -nuclear What happens to the matter that is lost?
31. Using chemical equations to show simple types of chemical reactions	31. Write the chemical equation for hydrogen combining with oxygen to form water.
(32.) Identifying various output from chemical interactions: precipitation, heat, gas, color change, and other changes detectable by an indicator	32. Name at least three possible results of a chemical reaction.
(33.) Identifying the basic principles of conservation of matter and energy	33. Name the priciples of conservation of matter and energy.
Energy and Heat (34.) Giving examles of different forms of energy, and describing ways in which one form of energy can be converted to another	34. Give an example of each kind of energy: -potential -kinetic -chemical -electric -heat -light Tell some ways that one form of energy is converted to another.
(35.) Tracing the energy in a given situation back to its original source (the sun)	35. Where does the energy you exert when you are riding a bicycle come from? Trace it all the way back to its origins.
36. Identifying ways that energy can be measured - calories, BTU's	36. What units are used to measure energy (such as the heat produced by a stove or furnace)?
(37.) Comparing and contrasting temperature and heat, and recognizing that a thermometer measures the degree of heat, not the amount of heat	37. What is the difference between the temperature of a stove and the amount of heat it contains? What does a thermometer measure?

SEVENTH GRADE F

38. Describing the effect of changes in heat content on the states of matter	38. Describe the effect that a change in the amount of heat has on water.
(39.) Identifying the three methods of heat transfer (convection, conduction, and radiation), and giving examples of each; recognizing that convection is the transfer of heat by another substance (e.g., a house is warmed by air or water carrying heat from the furnace to other parts of the house)	39. In what three ways is heat transferred from warmer to cooler places? Give at least two examples of each. How does convection work?
Electricity and Magnetism (40.) Diagramming the lines of force of two attracting and repelling magnets	40. Draw what the lines of force between these two pairs of magnets look like.
(41.) Classifying materials as magnetic and non-magnetic, and making generalizations about magnetic properties	41. Write a list of three magnetic and three non-magnetic substances. What generalizations can you make about subsances that are magnetic?
42. Distinguishing between the magnetic field produced by a current in a straight wire and in a coil	42. Sketch the magnetic field that forms around a wire when electricity is passed through it. How is that different from the field around a coil with electricity passing through it?
(43.) Describing the way in which a DC electric motor works	43. Using a drawing or a model, show how a DC electric motor works.
(44.) Describing the way in which a DC generator works	44. Using a drawing or a model, show how a DC generator works.
(45.) Identifying ways that static charges are produced, and defining their polarity	45. Where does static electricity come from? In the case of lightning, what is the polarity?

SEVENTH GRADE F

(46.) Recognizing how objects acquire a positive or negative charge	46. How can your body acquire a positive or negative electrical charge? When does this happen?
(47.) Recognizing that electric current is the movement of electrons (and ions) through a conductor	47. What is an electrical current?
48. Describing how a dry or wet cell battery produces electromotive force	48. How does a dry or wet cell battery work?
(49.) Using Ohm's Law to explain a simple electric circuit carrying current	49. In this circuit, how much current is flowing through the ammeter?  G = generator E = 10 volts R = 5 ohms A = ammeter
50. Giving examples of where conductors, resistors, and insulators (capacitors), and simple, series, and parallel circuits are used	50. In what everyday situations is each of these used? -conductors -resistors -insulators -simple circuits -parallel circuits -series circuits
(51.) Explaining the role of switches, fuses, and circuit breakers in household and industrial applications	51. How are switches, fuses, and circuit breakers used in homes and industry?
(52.) Explaining the difference between AC and DC current, and naming common applications of each	52. Where is AC current used? Where is DC current used? What is the difference between them?

SEVENTH GRADE F

(53.) Explaining how electrical energy operates at least one everyday device such as a radio, telephone, computer, etc.	53. Describe how a telephone works, using a drawing or model.
54. Explaining the basic operation of microcircuits ("chips") in current computer applications	54. Give a brief description of how the silicon "chips" in microcomputers work.
55. Identifying ways to measure the flow of electricity, and describing how to read a kilowatt-hour meter	55. How can a mechanic measure the flow of electricity in a car? How can you tell how much electricity is flowing into your home?
(56.) Defining volt, ampere, and ohm	56. What is the meaning of: -volt -ampere -ohm
57. Describing the production and transmission of electromagnetic waves	57. Describe how electromagnetic waves are initiated, how they are transmitted in space, and how they are received and converted to some useful communication purpose. How far and how long a period of time will an electromagnetic signal penetrate into space?
58. Identifying properties of electromagnetic waves (frequency, wave length, and speed in space)	58. Explain the properties of electromagnetic waves and how they are measured. What units are used? Draw a diagram of the electromagnetic spectrum and identify the useful kinds of radiation associated with long, medium, and very short wavelengths.
Mechanics (59.) Defining <u>force</u> as the capacity to: -set objects in motion -change an object's speed -change the direction of motion	59. What three things can a force do?
(60.) Describing machines (simple and compound) as devices for: -increasing a force -changing the speed of a force -changing the direction of a force and giving examples of each application	60. What are three things that a machine can do? Give an example of each.

SEVENTH GRADE F

(61.) Describing everyday uses of the six simple machines	61. Give an everyday application of: -a lever -a screw -a pulley -a wedge -an inclined plane -a wheel & axle
62. Giving examples of compound machines, and pointing out the simple machines that operate within each	62. Name at least two compound machines. Which of the simple machines above are at work in each one?
63. Calculating the mechanical advantage of simple machines	63. A woman pulls a 150-pound trunk up an inclined plane on a dolly using 50 pounds of pulling power. What is the mechanical advantage of the system she is using?
64. Recognizing that there are two kinds of mechanical advantage: the <u>ideal</u> based on the geometry of the situation without regard to the effects of friction; and the <u>actual</u> based on force ratios	64. What is the difference between the ideal and the actual mechanical advantage of a mechanical device? In the example just above, which kind of mechanical advantage did you calculate?
65. Applying the law of conservation of energy to different types of machines, pointing out where the energy in each machine goes, and comparing the relative efficiency of different machines	65. Where does the energy used by a car go? Try to think of all the possibilities.
(66.) Defining gravity, friction, and inertia, and explaining their relationship to work and energy (Newton's First Law of Motion)	66. Explain the meaning of gravity, friction, and inertia. How do they relate to work and energy?
67. Describing the basic laws that apply to space travel - gravity and inertia	67. What physical principles are at work in launching a space shuttle and keeping it in orbit?
68. Differentiating between, and giving examples of: gravity; friction; adhesion; cohesion; capillarity; and surface tension	68. Give the meaning and an example of: -gravity -friction -adhesion -cohesion -capillarity -surface tension
69. Describing the motion of objects in terms of position, displacement, forces, velocity, acceleration, and time	69. Relate the motion of objects in terms of Newton's first, second, and third laws.

SEVENTH GRADE F

(70.) Defining acceleration, and identifying the way it is affected by an object's mass and the net force applied to the object	70. Give an example of how an object accelerates, and name the variables involved in computing the velocity at any given moment.
71. Giving a simple example of the application of Newton's Second Law (the relationship between the mass of an object and its inertia)	71. How does mass relate to an object's inertia under a given set of conditions?
72. Giving a simple example of the application of Newton's Third Law (for every action there is an equal and opposite reaction)	72. Think of at least one everyday situation in which Newton's third law applies.
(73.) Identifying the factors affecting the motion of a small mass moving in a circle (centrifugal force)	73. Summarize the forces affecting a ball attached to a string being swung around a person's head.
Sound (74.) Describing the basic properties of sound: -it is a type of energy that takes the form of vibrations -it makes our eardrums vibrate, making us aware of sounds -it is transmitted through intervening media (such as air, water, wood) -it moves outward in all directions from its source -it moves in waves of varying frequency and amplitude, affecting the pitch and loudness -it travels at about 750 miles per hour (in the atmosphere at sea level at 32 degrees Fahrenheit)	74. How is sound energy propagated? What form does its energy take? What is the wave theory that is used to describe sound? How do we become aware of sound? How fast does sound travel in air? How is sound energy dissipated in a given medium? What happens to sound when it encounters a surface barrier? How do different surfaces affect sound differently?
(75.) Giving examples of the destructive effects of sound energy (e.g., high-pitched sounds breaking glass; loud noises causing damage to human ears)	75. How can sound be harmful? Give at least two examples.
76. Comparing the reflection and absorption of sound from different surfaces, and listing practical applications of this knowledge (e.g., soundproofing, acoustics)	76. What kind of material reflects sound best? What kind absorbs sound best? How is this knowledge applied?

SEVENTH GRADE F

(77.) Recognizing that the transmission of sound in a room is affected by the size and shape of the room as well as the materials used on the walls, floor, and ceiling	77. Check the factors that will have a direct affect the way sound behaves in a room: -whether there is a carpet -whether there are curtains -the height of the ceiling -the size of the room -the barometric pressure -the shape of the room -the number of people in it -the temperature
(78.) Comparing the speed of sound in the air (1100 feet per second) with the speed of light (186,000 miles per second), and giving examples of where this disparity becomes apparent (e.g., seeing lightning before hearing thunder)	78. What is the speed of sound? Of light? Give at least two examples of situations where this disparity becomes apparent.
79. Describing the frequency, amplitude, and wave length of water waves, and comparing and contrasting them to sound waves	79. Tell about an experiment with water waves, describing findings on the frequence, amplitude, and wave length of the waves. How do water waves compare with sound waves?
Light (80.) Describing the properties of light: -it travels in a straight line (unless affected by powerful gravitational fields) -unlike sound, it can travel through a vacuum -it travels at about 186,000 miles per second -its brightness diminishes the further it gets from its source (except in the case of laser beams)	80. How is light energy propagated? How is it affected by passing through different media? When is it bent from travelling in a straight line? How does it behave in a vacuum? How is it dissipated in space?
(81.) Describing the way in which light is reflected by a plane mirror, and how an image is formed, using schematic drawings	81. If you look at an apple through a mirror, where does the apple appear to be? Make a sketch showing how the rays of light travel from the apple to your eyes, and where the apparent image is.
82. Contrasting reflection and refraction, and describing conditions under which refraction occurs, using sketches	82. What is the difference between reflection and refraction of light? Give some examples of refraction, using sketches to illustrate.

SEVENTH GRADE F, G, H

83. Describing the conditions under which internal reflection occurs, using sketches	83. Make a sketch of at least one situation where internal reflection occurs.
84. Describing the effect of concave and convex lenses on light, distinguishing between real and virtual images	84. What do concave and convex lenses do to rays of light? Make sketches to illustrate each, showing the real and virtual images.
85. Describing the way in which images are formed in a compound microscope (using a diagram or sketches)	85. Make a sketch to show how an image is formed in the lens train of a compound microscope.
(86.) Recognizing that white light is made up of a spectrum of different-colored light, and describing how it can be separated out into the full spectrum	86. What is white light composed of? How can different colors be separated out?
87. Comparing and contrasting the wave and particle models of radiant energy, and recognizing that neither theory fully explains the properties of light energy	87. Briefly describe the wave theory of radiant energy. Do the same for the particle model. Which one explains everything about how light behaves?
88. Recognizing that color is determined by the frequency of light waves	88. What determines the color of light?
89. Recognizing that visible light is only a small part of the electromagnetic spectrum, which is continuous from radio waves through light to gamma rays	89. Where is visible light on the total electromagnetic spectrum of radiant energy? How much of the spectrum does it take up?
G. EARTH SCIENCE [No objectives at this level]	
H. ASTRONOMY [No objectives at this level]	

SEVENTH GRADE I

I. SCIENCE READING	
(1.) Reading at least three of the science books or magazines listed at the end of the eighth grade objectives, either as part of the individual project (objective A-2), or as a separate activity	1. Teacher observation and record keeping

EIGHTH GRADE

A. SCIENCE EXPERIENCES

(1.) Carrying out and reporting on at least one hands-on science experiment or project, working individually or in small groups. The topics of the experience should be chosen by each student, drawing on the content for this grade level (see sections C - H) or other topics of interest. The experience is open-ended in terms of content, but should incorporate as many of the following general science processes as possible:

1. Stating what you want to find out in clear and precise terms
2. Planning the project or experiment, deciding what equipment and materials are needed and gathering them, and deciding whether a set of control observations is required
3. Stating a hypothesis (an educated guess) about what might happen
4. Carrying out the experiment or project, controlling and systematically changing variables
5. Observing and describing what happened, using measurement instruments to get precise readings where necessary; testing the hypothesis
6. Keeping records of data gathered
7. Sorting, comparing, and classifying the information gathered, looking for patterns and regularities
8. Analyzing the data, and arriving at logical conclusions
9. Presenting the conclusions in oral, written, or graphic form

1. Teacher observation: By the end of the year, has the student completed and reported on at least one hands-on science experience which includes most of the science processes and skills?

   Some possible experiences:
   - systematically observing changes in plants and animals over time
   - systematically observing changes in the weather over time
   - performing experiments with plants and different forms of light and nutrients
   - repairing a household appliance by using the manual or other source of information
   - building or developing something, e.g., a computer game, amplifier, radio, electronic device, etc.
   - testing audio amplifiers, intercoms
   - building simple short wave receiver
   - building a seismograph, photometer
   - building radio transmitter
   - building a refracting telescope
   - charting constellations
   - glider design, construction
   - hot air balloon design, flight
   - air tunnel studies
   - pond organisms
   - aquatic higher plants

(2.) Using books (see section I), interviewing, field trips, or other personal experiences to find out a great deal about one topic, and presenting a written report on that topic

2. Teacher observation: Has the student chosen a topic, made a thorough investigation of it, and presented an acceptable report?
   - space station plans, strategies, prospects
   - rocket design, programming
   - rocket probes planned
   - space travel and politics
   - lunar watch studies
   - sunspot cycle

EIGHTH GRADE B

B. SCIENCE SKILLS AND PROCESSES

Observing

1. Observing carefully, noticing such details as size, shape, color, texture, weight, smell, taste, position, time taken, etc.

2. Recognizing ways in which different people observe the same phenomena differently, and identifying ways to make measurements more objectively

Measuring

3. Identifying the appropriate measuring instrument and unit of measure for a task [Correlates with Math objectives]

4. Measuring length in English and metric units [Correlates with Math objectives]

5. Measuring weight in English and metric units [Correlates with Math objectives]

6. Measuring time to one half, one fifth, and one tenth of a second [Correlates with Math objectives]

7. Measuring temperature in degrees Fahrenheit or Celsius [Correlates with Math objectives]

8. Measuring volume in English and metric units [Correlates with Math objectives]

9. Measuring angles, using a protractor [Correlates with Math objectives]

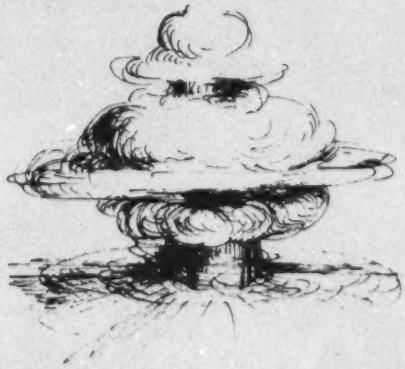
10. Knowing how to interpolate readings between known readings on measurement instruments [Correlates with Math objectives]

1-13
These skills and processes should be applied and assessed in the Science Experiences, Life Science, Human Biology and Health, Physical Science, Earth Science, and Astronomy sections. Specific right-hand column examples are not given in order to encourage the application of the skills to all content areas. The substantial overlap of these skills with those in the mathematics curriculum document makes it possible to teach many science and mathematics skills simulaneously.

EIGHTH GRADE B

(11.) Estimating length, weight, temperature, etc. when approximate readings are adequate [Correlates with Math objectives]	
Classifying (12.) Organizing and classifying objects and information	
Recording (13.) Recording information in the form of sketches, graphs, tables, charts, narrative, etc., and interpreting data recorded by others [Correlates with Math objectives]	
Using Equipment (14.) Using and maintaining laboratory equipment, and identifying safety hazards of some items	14. Teacher observation
Scientific Method (15.) Identifying and distinguishing between the major aspects of the scientific method in experiments and investigations	15. In an experiment you have performed this year, give examples of each of the following: -observations -inferences -hypotheses -predictions -assumptions -variables -conclusions
(16.) Identifying other key factors in valid scientific work, e.g. -a large enough sample -repeated trials -telling significant from insignificant data	16. What are three important things that scientists need to be confident about the results of an experiment?
(17.) Relating at least one story of an important scientific discovery, describing the factors that contributed to its success (persistence, skill, cooperation, luck, etc.)	17. Tell the story of at least one important scientific discovery, describing what factors contributed to success.

EIGHTH GRADE B, C

(18.) Relating at least one story of a scientific fraud, and identifying how it was discovered; some possibilities: -Midwife toad -Piltdown man -Cardiff giant -Cuvier hoax -Leisenkovism -Cyril Burt -William Darsee [maintained]	18. Tell about at least one scientific fraud. In what way were people misled? How was the fraud discovered?
C. SCIENCE AND SOCIETY	
(1.) Distinguishing between science and technology ("pure" versus "applied"), and giving examples of each [maintained]	1. What is the difference between science and technology? Give examples of each.
2. Describing the impact of at least three scientific/technological advances of the past (e.g., the development of the arch by the Romans, the discovery of selective breeding, the development of the microscope, etc.) [maintained]	2. Name at least three important scientific discoveries or inventions made before 1900, and tell about the effect they had on human civilization. 
3. Recognizing that human population growth is the result of medical and other advances that prolong life, of the decrease in infant mortality, and of the elimination of disease [maintained]	3. Why has the human population of the world "exploded" in recent years?
(4.) Briefly describing the impact of at least three recent scientific/technological advances (e.g., nuclear power, gene splicing, data banks, word processing, robotics, laser technology, etc.) [maintained]	4. Name at least three important scientific discoveries or inventions made since 1900, and tell about the effects they have had on our lives.

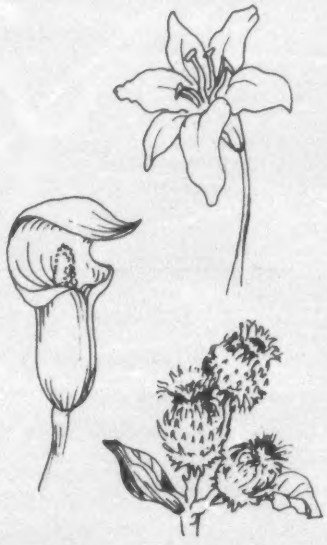
EIGHTH GRADE C

(5.) Identifying the sequence of some major scientific and technological breakthroughs [maintained]	5. Number these in the order in which they took place: -the first balloon flight -the first flight to the moon -the first automobile -first use of anesthetics -first use of gunpowder -first use of fire -the first use of paper
(6.) Giving an example of scientific work being influenced by the beliefs or traditions of a particular era [maintained]	6. How is scientific work affected by the beliefs people hold in a particular period? Give an example.
(7.) Identifying the world's major problems (population growth, food shortages, energy and resource depletion, nuclear stand-off, pollution, etc.), and indicating the role of science and technology in dealing with each [maintained]	7. What do you think are the most pressing problems facing humans today? Can science help solve them? How so?
(8.) Identifying the pros and cons of at least one current scientific or technological issue (examples from previous years might include Three Mile Island, toxic waste dumps, the space shuttle, DNA research, etc.)	8. Tell about at least one science-related story that has been reported on TV or in the newspapers this year. Why was it important?
(9.) Describing some examples of "non-science", and outlining the debate between their proponents and their scientific critics; some possibilities: -astrology -psychokinesis -E.S.P. -Bermuda Triangle -Atlantis -U.F.O.s -dowsing rods -pyramid power -astrology -tarrot cards [maintained]	9. Give at least four examples of strong beliefs that some people hold that are not backed up by scientific evidence. Tell both sides of the debate between scientists and people who hold each set of beliefs. Is it important that these beliefs are not scientifically provable?

EIGHTH GRADE C, D

(10.) Decribing the major contributions and some biographical details about a few well-known scientists, including some who are women and minorities [maintained]	10. Choose at least five important scientists (make sure our list includes a male/female and racial/ethnic mix) and tell briefly about the life and work of each. [See list in appendix.]
(11.) Identifying the pros and cons of an ethical issue involving science and technology, where what is technically possible conflicts with some people's beliefs, interests, etc., and making a case for one side; for example: -pollution control versus the loss of jobs it may cause -nuclear power plants versus the health risks they may produce -DNA research versus the fear of genetic meddling -the cost of space travel versus the needs of starving people on Earth -birth control versus the religious beliefs of some people -laboratory experiments on animals	11. Choose one scientific/technologial issue about which there is a heated debate going on. Explain both sides of the argument, and then make a case for the side which you think has the strongest case.
(12.) Identifying at least 20 science-related vocations and avocations; describing the education and other training necessary to gain access to five of them; and identifying the impact these five jobs have on the lifestyle of a person and his or her family	12. Name at least twenty hobbies and jobs that involve science and technology. What level of education and training would you need to get each of the jobs? What kinds of demands do they make on a person and his or her family?
D. LIFE SCIENCE	
Micro-Organisms	
(1.) Describing the ways in which viruses can be considered both living and non-living	1. Describe the life history of a virus and explain qualities that make it like non-living material and qualities that make it like a living cell.
(2.) Distinguishing between viruses and bacteria, and describing the basic characteristics of each	2. Compare bacteria and viruses. How do they differ? In what ways are they alike?

EIGHTH GRADE D

(3.) Based on microscope observation of the four types of protozoans, identifying their major characteristics; describing their importance to humans	3. Based on your own observation through a microscope, give a general description of four genera of protista: ciliate, flagellate, coccoid, colonial. How does each affect our lives?
Plants (4.) Recognizing the main characteristics that differentiate the four major divisions of plants, and being able to classify plants into these divisions	4. What are the main characteristics of the following plant divisions: thallopytes, bryophytes, pteridophytes, and spermatophytes? Name at least two kinds of plant in each division.
(5.) Identifying the structural differences between monocotyledon and dicotyledon plants, and between vascular and non-vascular plants	5. What are the major differences between: -monocotyledon seedling -dicotyledon seedling -a monocot leaf -a dicot leaf -a non-vascular plant (either gametophyte or sporophyte -a vascular plant (stem structure)
6. Recognizing the most common plants of eastern Massachusetts (edible, ornamental, industrial, poisonous)	6. List the common wild plants you know and can identify in the eastern Massachusetts flora. If possible, give both the common and the Latin name. 

EIGHTH GRADE D

(7.) Identifying the structures and functions of the major parts of plants and plant tissues	7. Diagram and label figures of a whole, herbaceous, flowering plant. Using insert drawings, show the important tissues in each part (stem, leaf, root, flower, etc.), and give a brief account of what processes take place in these parts and their tissues.
(8.) Describing the process of photosynthesis in terms of the conversion of solar energy into food and oxygen, giving the basic elements, compounds, and mixtures needed for it to occur	8. Describe the phases of photosynthesis, including the raw materials, sources of energy, and important by-products. What is the importance of photosynthesis to life on Earth?
(9.) Identifying the ways in which plants and molds spread from place to place (seeds carried by birds, the wind, humans, etc.; spores blown by the wind)	9. How do plants propagate their kind in the natural environment? Tell how weather, season, and other factors play a part.
(10.) Recognizing that insecticides protect plants from certain insects, and giving some pros and cons of insecticide use	10. Give examples of the use of certain insecticides to control pests in orchards and gardens. Give examples of natural controls, and explain why systemic chemicals may present more problems than they solve.
(11.) Identifying the way in which flowering plants reproduce (fertilization, germination, etc.), and the alternative ways for plants to start a new generation (cuttings, layering)	11. Explain how flowering plants reproduce their kind. Tell how horticulturists propagate a certin strain of fruit by bypassing the sexual reproduction cycle to maintain a clonal stock for fruit raising.
(12.) Identifying the types of pollination and the role of pollination in plant reproduction	12. Review the known kinds or processes of pollination known among flowering plants - how species-specific or genus-specific some of these are, and how only one particular species of insect will suffice.
Animals (13.) Differentiating between plants, animals, protists, monerans, and fungi, and giving the characteristics of each	13. Tell how the following major groups of organisms differ, giving characteristics and examples of each: -protista -true plants -monerans -true animals -fungi

EIGHTH GRADE D

(14.) Distinguishing between air- and gill-breathing animals	14. Which of these are air-breathing and which are gill-breathing? -seals -porpoises -eels -cod -penguins -whales
(15.) Comparing and contrasting the major phyla of animal life, giving examples of each	15. What are the main differences between each of these phyla? -Protista -Porifera (sponges) -Collenterata (jellyfish) -Platyhelminthes (flatworms) -Nematoda (round worms) -Mollusca (shellfish, etc.) -Annelida (segmented worms) -Arthropoda (crustaceans, insects) -Echinodermata (sea urchins, starfish) -Chordata Add other phyla if you wish.
(16.) Identifying the diversity that exists in the structures of different organisms (e.g., body covering, locomotion, protection, etc.) and the functions that each adaptation serves	16. Compare and contrast various ways animals feed, move around, escape enemies, catch prey, protect their bodies from attack, confuse their enemies, protect their young, etc. Explain the role that adaptations play in each.
(17.) Identifying the characteristics and adaptations of warm-blooded and cold-blooded animals	17. Describe the characteristics of warm-blooded and cold-blooded animals, giving some examples. What adaptations help each survive?
(18.) Identifying differences and similarities between the major plant and animal systems	18. Compare and contrast the physiological systems in plants and animals: -respiration -digestion -circulation -excretion -etc.
(19.) Describing the series of changes that each plant and animal goes through as part of its individual life cycle from cell to maturity	19. What are the most important stages that plants and animals go through as they grow from single cells to full maturity?

EIGHTH GRADE D

20. Describing the sequence of stages in the growth and development of a typical higher insect: -zygotes to larva -metamorphosis to pupa -metamorphosis to male/female adult -production of sperm/egg, which combine to form zygote	20. Describe the life history of an insect of your choice. Explain the process at each stage in detail.
(21.) Identifying the kinds of animals that reproduce by fission	21. Name some living things that reproduce by fission.
(22.) Recognizing that the cells in developing animals divide, differentiate, and specialize to perform specific functions (blood, bones, tissue, etc.)	22. As an animal grows from a single cell, how are different parts of its body formed?
(23.) Describing the function of various forms of animal behavior [maintained]	23. How does each of these behaviors help animals survive? -hibernation -migration -territoriality -pecking order -playing dead -remaining motionless -bluffing attacks -intricate performance rituals -specific calls (birds) -vocal messages or patterns -flocking or schooling
(24.) Identifying the ways a particular organism provides for its needs	24. Choose one plant or animal and tell how it provides for: -nutrition -external covering -gas exchange -support -locomotion -reproduction -growth -reaction to external stimuli
(25.) Describing ways in which humans are dependent on animals (companionship, entertainment, work, food, laboratory experimentation), and exploring some of the moral issues involved [maintained]	25. Name at least ten ways that humans use animals today. Consider the argument that "animals have rights too." Could we use animals less and still be able to carry on our research in branches of zoology and medicine? Is it appropriate to save human lives at the expense of animal lives?

EIGHTH GRADE D

Cell Theory 26. Recognizing that the cell is the basic unit of all living things	26. What is the basic unit of all living things?
27. Identifying the main parts of a typical cell as seen through a microscope, and stating their functions (nucleus, cell wall, chloroplasts, vacuole, cell membrane, ribosomes, mitochondria)	27. As seen through a microscope, what are the main parts of a typical cell? Make a sketch to illustrate. What does each part of the cell do?
28. Identifying the differences between plant and animal cells that are visible under a microscope	28. What main differences can you see between plant and animal cells looking through a microscope?
29. Describing the growth and division of cells, the conditions they need to grow and survive, and the reason that cells cannot grow larger than a certain size	29. What factors limit the growth of a single cell? How do cells grow and reproduce if they are so limited? Explain.
30. Describing two kinds of cell division: -mitosis - growth by splitting -meiosis - preparation of the gametes to reduce the number of chromosomes	30. Explain the difference between mitosis and meiosis.
31. Identifying the cell division that many-celled animals go through, starting with fertilized egg, dividing and re-dividing, differentiation into different kinds of cells, formation of tissue, organs, and systems	31. Explain what happens as the fertilized cell of a new human being grows and divides inside its mother.
Anatomy 32. Identifying common names of animal and plant organs, and differentiating between organs and complex tissues	32. Name some organs that are present in most animals' bodies. What is the difference between these organs and complex tissues?
33. Defining the word organism, and contrasting organisms to living things that are not organisms	33. What is an organism? How can you differentiate between an organism and a living thing that is not an organism?
34. Describing digestion as the process by which plants and animals turn food into usable chemicals	34. What is the purpose of the process of digestion in plants and animals?

EIGHTH GRADE D

(35.) Describing the ways in which substances diffuse through cell membranes by osmotic force, and identifying the function of permeable, semi-permeable, and impermeable cell membranes	35. Tell what osmosis really is and how it works. How are permeable, semi-permeable, and impermeable cell membranes involved?
(36.) Describing the elodea cell's way of interacting with salt and fresh water	36. How does the elodea cell interact with salt water and fresh water?
(37.) Describing the processes of osmosis and diffusion, and giving examples of how they help cells	37. How do osmosis and diffusion work, and how do they help cells survive and grow? Give at least two examples.
38. Discriminating between objects of biological origin and artifacts of slide preparation (as seen through a microscope)	38. Some objects seen through a microscope appear to be living when in fact they are bubbles, dust, etc. What are some ways you can tell living from non-living things when examining them through a microscope?
39. Distinguishing between active and passive transport	39. What is the difference between active and passive transport? Give examples.
Classification	
(40.) Recognizing that Carolus Linnaeus developed the modern system of classifying organisms	40. Who is responsible for developing the system of classifying organisms that is used today?
(41.) Identifying the sequence of the levels (taxons) in the Linnaean system: kingdom, phylum, class, order, family, genus, species	41. What are the levels in this system?
(42.) Recognizing that kingdom is the largest grouping of organisms and species is the smallest grouping	42. Which of these levels encompasses the most organisms? Which is the narrowest?
(43.) Recognizing that the criterion for assignment to the same species is the ability of two organisms to mate and produce normal, fertile offspring	43. How do scientists decide whether two organisms should be assigned to the same species?
(44.) Recognizing that each organism has a two-part Latin name, indicating its genus and species	44. What language is used for the formal names for species? In the name for a species, which part of the word stands for the genus, which for the species?

EIGHTH GRADE D

(45.) Recognizing that the scientific name for humans is Homo sapiens sapiens	45. What is the full Latin name for the species to which we belong?
Ecosystems (46.) Recognizing that most interactions in a community of organisms involve competing for food, eating, and avoiding being eaten	46. In an ecosystem, what are the main ways in which living things interact?
(47.) Tracing the flow of energy through a food chain	47. Consider a trout swimming in a pond. Where did the energy in its body come from originally? What path did that energy follow?
(48.) Describing how an environment of living things reaches equilibrium (stable populations controlled by the food supply), and how the introduction of a new element can upset that balance	48. What is necessary for an ecosystem to be in equilibrium? Give an example of how a stable ecosystem can be thrown out of balance.
(49.) Drawing a diagram of a food pyramid and a food web to show the interconnections of several food chains, and showing how a pollutant that does not break down (such as DDT) becomes increasingly concentrated at the higher trophic levels	49. Diagram a stable, balanced food chain in the form of an inverted pyramid, using these elements: green leaf vegetation, insects, frogs, salamanders, rabbits, foxes, mountain lions. If the green leaf vegetation is sprayed with DDT, what happens to the chemical in the food chain?
Evolution (50.) Describing the scientific theory of evolution: -each species tends to overproduce, giving birth to more individuals than the environment can support -each species brings forth a variety of offspring because of new combinations of genetic material in sexual reproduction, and because of occasional mutations -those individuals that happen to be best adapted to the environment survive, while those who are less well adapted become extinct (natural selection) -over long periods of time, this process brings about changes of species - evolution - and brings into being new species	50. Describe the major parts of the scientific theory of evolution.

EIGHTH GRADE D

-all living things evolved in this manner from single-celled organisms in the primitive water 3-1/2 billion years ago, with the order being: cells, worms, fish, amphibians, reptiles, birds and mammals, primates, and humans	
(51.) Describing the contribution of Darwin and Wallace to the development of the theory of evolution	51. How did Darwin and Wallace contribute to developing this theory?
(52.) Comparing the process of evolution in nature to the process of selective breeding of plants and animals by humans	52. What are the similarties and differences between evolution in nature (as explained by the scientific theory) and selective breeding of horses and dogs by humans?
(53.) Identifying three kinds of evidence that support the scientific theory of evolution: -the fossil record contains many intermediate stages of some animals, indicating gradual change over time -the basic chemicals in all living things are the same (amino acids, proteins, and DNA) -humans have vestigial organs (such as the appendix) and go through developmental phases <u>in utero</u> (growth of gill slits and tail) which suggest that we evolved from lower forms of life	53. What scientific evidence is there for the theory of evolution?
(54.) Describing some of the criticisms that have been made of the scientific theory of evolution, both religious (literal interpretation of the Book of Genesis), and scientific (the new "punctuated equilibrium" theory)	54. How has the theory of evolution been criticized by scientists? How has it been criticized by non-scientists?
(55.) Describing the evolutionary change of a particular animal over time	55. Use sketches and/or descriptions to show how the horse evolved from Eohippus to Equus during the Tertiary and Quaternary.

EIGHTH GRADE D

(56.) Recognizing that most animals and plants are "trapped" in the environment for which their bodies evolved, while humans can survive in almost any environment (the North Pole, Death Valley, the ocean floor, outer space) [Correlation with Social Studies objectives] [maintained]	56. Are humans more or less adaptable than other living things on Earth? Explain.
Heredity (57.) Describing the contributions of Gregor Mendel to the science of heredity	57. What were the main contributions of Gregor Mendel to the science of heredity?
(58.) Identifying the basic laws of heredity in plants and animals: -like begets like -each individual (except identical twins) is different because of different combinations of genetic material in sexual reproduction -only inherited traits (not acquired traits) are passed along -genes carry dominant and recessive traits, which appear in future generations under particular conditions	58. Describe the most important laws of heredity in plants and animals.
(59.) Identifying DNA (deoxyribonucleic acid) as the chemical that encodes all the genetic information in each cell	59. What complex molecule contains all the hereditary information in each of our cells?
(60.) Recognizing that the same hereditary substance (DNA) is present in the cells of <u>all</u> living things on Earth, from grass to elephants	60. What complex molecule carries genetic information forward to the next generation in each of these: -humans -dogs -whales -oak trees -ants
61. Recognizing that the almost infinite variations of only four different building blocks in DNA account for the extraordinary variety of life on Earth	61. DNA has only four basic building blocks. How can there be so many different kinds of living things on Earth?

EIGHTH GRADE D, E

(62.) Distinguishing between sexual and asexual reproduction in plants and animals: -sexual - flowers, fish, reptiles, etc.; each individual is unique -asexual - cloning, growth from cuttings of plants, layering; the new individual is identical to the "parent"	62. Give some examples of sexual and asexual reproduction.
(63.) Describing the function of DNA as a plant or animal goes through meiosis, mitosis, and growth	63. Describe the role of DNA in the reproduction of a plant or animal.
E. HUMAN BIOLOGY AND HEALTH **Health and Nutrition** (1.) Identifying conditions, both physical and psychological, that detract from good health [maintained]	1. Make a list of at least ten activities or substances what make people less healthy.
(2.) Categorizing foods in the five groups, and identifying which of the first four is not represented in a day's meals and snacks: -fresh fruits and vegetables -whole grain breads and cereals -dairy products -meat, eggs, nuts, beans, etc. -"junk foods" - candy, cookies, soft drinks, chips, etc.	2. Which (if any) of the first four food groups is not represented in this day's meals and snacks? -cereal, toast, jam, tea -tuna, lettuce, and tomato sandwich, milk, cookies -ice cream cone -steak, potatoes, green beans, salad -hot fudge sundae
(3.) Identifying the effects of an inactive lifestyle on human health, and describing steps that can be taken to combat these effects	3. When people do not exercise, what is the effect on their bodies? Name some ways that people can avoid these effects.
(4.) Identifying the effects of obesity and high blood pressure on human health, and describing treatments for both	4. What are the effects of being very overweight? Of having high blood pressure? What do doctors recommend for people with each health problem?
(5.) Identifying some major hereditary diseases (e.g., hemophilia, sickle cell anemia, diabetes), and steps that are being taken to combat them [maintained]	5. Name at least five diseases that people may inherit from their ancestors. What are the latest treatments for each disease?

EIGHTH GRADE E

(6.) Identifying some major deficiency diseases, and steps that can be taken to combat them [maintained]	6. Name at least two deficiency diseases. What do doctors recommend for people with each disease?
(7.) Identifying major communicable diseases, including those that are sexually transmitted, and describing how they are treated and how people can avoid them	7. Name at least ten communicable diseases, including some STD's. How do doctors treat each one? What are some ways people avoid each one?
(8.) Describing the effects of various drugs on the human body , and the psychological and physical factors that lead people to abuse them; describing steps that can be taken to escape the grip of such drugs	8. For each drug, describe the effect it has on the human body, the reasons people use and abuse it, and ways that people can escape its bad effects. -coffee -tobacco -alcohol -sleeping pills -marijuana -heroin -amphetamines -"angel dust" -LSD -others
(9.) Differentiating between ailments (both physical and psychological) that one can treat oneself, and those that require a doctor's care	9. Make a list of physical or psychological problems you should definitely see a doctor about. Now make a list of problems that it would be safe to treat yourself.
(10.) Describing symptoms and causes of bodily distress (heart attack, suffocation, choking, stroke, etc.), and identifying the appropriate action to take in each case	10. Describe some signs of extreme bodily distress, what causes each problem, and what you could do to help a person in each case.
(11.) Identifying some procedures that a person can use to monitor his or her general health (e.g., taking pulse, temperature, etc.), and the ways in which a doctor can supplement such information with other data (blood pressure, the sound of the lungs, etc.) [maintained]	11. Name at least three ways that you can check to see if your body is healthy. What are some ways a doctor can get more information?

EIGHTH GRADE E, F

(12.) Identifying ways the body can protect itself from bacterial infection: -protective covering -white blood cells engulfing most intruding bacteria -antibodies that render other bacterial toxins harmless -innoculations	12. Name at least four natural and human-made ways that our bodies are protected against bacterial infection.
(13.) Diagnosing certain diseases from a list of symptoms, and suggesting possible treatment	13. What disease is probably present in a person with these symptoms? -high temperature -vomiting -aching joints -general lassitude
Safety (14.) Identifying some major safety hazards for this age group, and describing ways of minimizing the risks of each one: -pedestrian accidents -injuries in automobile accidents -bicycle accidents -burning buildings (prevention and escape) -various tools -eye injuries -swimming -contact sports [maintained]	14. What are some ways that people your age are injured and killed? Make a list of at least ten, and after each one write some ways you might reduce your own risk of being a victim.
(15.) Identifying substances that have been proven to be or are suspected of being carcinogenic (e.g., asbestos, lead, DES, tobacco, cyclamates, etc.), and indicating places where they are found [maintained]	15. Name at least three substances that are thought to cause cancer, birth defects, and other serious health problems. Where are these substances often found?
F. PHYSICAL SCIENCE [No objectives at this level; see Grade Seven, which concentrates on Physical Science]	

EIGHTH GRADE G, H, I

G. EARTH SCIENCE [No objectives at this level]	
H. ASTRONOMY [No objectives at this level]	
I. SCIENCE READING 1. Reading at least three of the following science books or magazines, either as part of the individual project (objective A-2), or as a separate activity	1. Teacher observation and record keeping

SIXTH, SEVENTH, AND EIGHTH GRADE SCIENCE BOOKS

Adams	Catch a Sunbeam: Book of Solar Study Experiments
Adkins	Moving Heavy Things
	Wooden Ships, The Building of a Sailing Vessel
Adler	The Calendar
Alth, Charlotte and Max	Disasterous Hurricanes and Tornadoes
Anderson	Halley's Comet
Andrews	All About Dinosaurs
Angrist	Other Worlds, Other Beings
Anno	Anno's Medieval World
Arnold, Ned and Lois	The Great Science Magic Show
Arnov	Water: Experiments to Understand It
Asimov	How Did We Find Out About Oil?
	How Did We Find Out About Earthquakes?
	Galaxies
	Environments Out There
Attenborough	Discovering Life on Earth
Atwood	The Wild Young Desert

EIGHTH GRADE I

	The Kingdom and the Forest
Aylesworth	It Works Like This
	Storm Alert: Understanding Weather Disasters
	Alchemists: Magic Into Science
Barkin	How to Keep a Secret
Barry	Kingdom of Wolves
Baumann	Devil's Triangle
	Monsters of North America
Beller	So You Want to Do a Science Project?
Bendick	Super People: Who Will They Be?
	First Book of Automobiles
	Why Things Work: A Book About Energy
Bengtsson and Atkinson	Orienteering for Sport and Pleasure
Berger	Disastrous Volcanoes
	Disastrous Floods and Tidal Waves
	Computers in Your Life
	From ESP to UFO's
	Disease Detectives
	Quasars, Pulsars, and Black Holes in Space
	Storms
Bershad	Bodyworks: Kids' Guide to Food and Physical Fitness
Bevans	Book of Reptiles and Amphibians
Bixby	Hurricanes
Bliss, Sands and Co.	The Magic Moving Picture Book
Bloch	Dinosaurs
Blumberg	UFO's
	Sharks
Boek	Cosmic View: The Universe in 40 Jumps
Bosiger	A Bird Is Born
Boy Scouts of America	Official Boy Scout Handbook
Brady	Wild Babies: A Canyon Sketchbook
Bramwell	Rand McNally Wildlife Atlas of the World
Brandhorst	The Tale of Whitefoot

EIGHTH GRADE I

Branley	Columbia and Beyond: Story of a Space Shuttle
	The End of the World
	Feast of Famine: The Energy Future
	Book of Mars for You
	Jupiter: King of the Gods, Giant of the Plants
Brindze	Hurricanes: Monster Storms Drom the Sea
Brooklyn Botanical Garden	Dye Plants and Dyeing
Brown, Joseph	Grains: An Illustrated History With Recipes
	Knowing the Outdoors in the Dark
Brown, Walter	Catastrophies
Buchenholz	Doctor in the Zoo
Buck	Where They Go in Winter
Budlong	Experimenting With Seeds and Plants
Burns	This Book Is About Time
	The I Hate Mathematics Book!
Burstall	Simple Working Models of Historic Machines
Burstein	Slim Goodbody: What Can Go Wrong and How to Be Strong
Bygrave	Motorcycle
Caras	Zoo in Your Room
Carlo	The Juggling Book
Challand	Science Activities From A to Z
Charlip and Joyner	Handtalk
Cherrier	Fascinating Experiments in Chemistry
	Fascinating Experiments in Physics
Cherry	Steel Beams and Iron Men
Cipriano	America's Journeys Into Space: The Astronauts
Clemens	Superanimals
Clement	Hammond Nature Atlas of America
Cobb	Science Experiments You Can Eat
	More Science Experiments You Can Eat
	Secret Life of School Supplies
	How to Really Fool Yourself
Cobb and Darling	Bet You Can't! Science Impossibilities to Fool You
Coerr	A Baby Whale Borrowed for Science

EIGHTH GRADE I

Cohen	Color of Man
	Ancient Visitors
Colby	Hidden Treasure: What, Where, and How to Find it
	Building Wrecking
Cole	Cockroaches
	Fleas
Coombs	Skylab
Cooper	Science in Your Own Backyard
Corbett	Bridges
Cosgrove	Bone for Bone
Crocker	New Good and Easy Cookbook
Crosby	Tarantulas: Biggest Spiders
Curtis	Greff: Story of a Guide Dog
Cusack	Is There a Bermuda Triangle?
Darling	The Gull's Way
Davis	Biography of a Fish Hawk
	Into the Dark: A Study in Animal Communication
Day	Secret World of the Baby
Dean	How Animals Communicate
Delear	Famous First Flights Across the Atlantic
Dennis	Catch the Winds: A Book of Windmills and Wind Falls
Devi	Figuring: The Joy of Numbers
D'Ignazio	Creative Kids Guide to Home Computers
	Working Robots
Dietrich	Stones: Their Collection, Identification, and Use
Dobrin	Marshes and Marsh Life
Dobrin	Great Men of Science
Dowden	Wild Green Things in the City
Earle	Camels and Llamas
Edwards	Caring for Trees on City Streets
Ennion and Tinberger	Tracks
Facklam	Wild Animals, Gentle Women
Faulkner	Days When the Animals Talked
Fichter	Keeping Amphibians and Reptiles as Pets

EIGHTH GRADE I

Flanagan	Window Into an Egg: Seeing Life Begin
Flanagan and Morris	Window Into a Nest
Fletcher	Fishes Dangerous to Man
Fodor	Frozen Earth: Exploring the Ice Ages
Ford and Keiper	The Island Ponies
Fox	Jane Goodall: Living Chimp Style
Freedman	How Birds Fly
	Animal Superstars: Biggest, Strongest, Fastest
Freeman	When Air Moves
Fuch	Looking at Maps
Gallant	Earth's Changing Climate
	Exploring the Universe
Gallob	City Rocks, City Blocks and the Moon
	City Leaves, City Trees
Gamow	One, Two, Three Infinity
Gardner	Aha! Gotcha! Paradoxes to Puzzle and Delight
Giambarba	Surfmen and Lifesavers
Gilbert	Fat Free: Common Sense for Young Weight Worriers
	Feeling Good
Gilfond	Disastrous Earthquakes
	New Ice Age
Gilmore	Model Boats for Beginners
Gilmour	Understanding Your Senses
Girl Scouts of USA	Cadette Girl Scout Handbook
Goetz	Tropical Rain Forests
Goldreich	What Can She Be? A Scientist
	What Can She Be? A Computer Scientist
	What Can She Be? A Veterinarian
Goldsmith	Why You Get Sick and How You Get Well
Graham	Bug Hunters
	Falcon Flight
	Coyote Song
	Whale Watch
Greger	Simple Fabric Kites
Greene	Before the Dinosaurs

EIGHTH GRADE I

Greenhood	Mapping
Gregory	The Intelligent Eye
Gross	Alligators and Other Crocodilians
Grunfeld	Games of the World
Haber	Women Pioneers of Science
Haines	Cancer
Halstead	Tropical Fish: Guide for Settin Up an Aquarium
Hamerstrom	Adventure of the Stone Man
Hammond	Hammond Almanac of a Million Facts
Hancock	Supermachines
Handel	A Dog Named Duke, True Stories of GM
Harman	A Skyscraper Goes Up
Hayden	Eight Black American Inventors
	Seven Black American Scientists
Herbert	Mr. Wizard's Supermarket Science
Hess	Praying Mantis: Insect Cannibal
	Sea Horses: Story and Photographs
	Pigeons Everywhere
	The Misunderstood Skunk
	Bird Companions
Heuer	Rainbows, Halos and Other Wonders
	Thunder, Singing Sards, and Other Wonders
Hewett	Watching Them Grow: Inside a Zoo Nursery
Hillcourt	Fun With Nature Hobbies
Hofsinde	Indian Music Makers
Hoke	Terrariums
Holbrook	A Closer Look at Elephants
Holling	Paddle-to-the-Sea
Holloway	The Handbook of Photographic Equipment
Holmes	Early Morning Rounds: A Portrait of a Hospital
Hopf	Biography of a Rhino
	Biography of a Snowy Owl
Hornblow	Animals Do the Strangest Things
	Insects Do the Strangest Things
	Reptiles Do the Strangest Things
	Birds Do the Strangest Things

EIGHTH GRADE I

Horwitz	How to Wreck a Building
Hosking	Kites Aussie Style
Houghton-Mifflin	Field Guides (Advanced):
	Animal Tracks
	Atlantic Coast Shells
	Reptiles and Amphibians
	Rocks and Minerals
	Birds
	Insects
	Mammals
	Trees
	Wildflowers
Hoyle	Highlights in Astronomy
	Astronomy: A History of Man's Investigation of the Universe
Hughes	A Closer Look at Bees and Wasps
Hutchins	Grasshoppers and Their Kin
Hyde	Cranes in My Corral
	Is the Cat Dreaming Your Dream?
	Computers that think: Search for Artificial Intelligence
Ipsen	Rattlesnakes and Scientists
Italiano	Sleighs: The Gentle Transportation
Jacobs	Jumbo Jets
	Sargasso Sea
Jenness	Dwellers of the Tundra
Johnson	Creating With Paper
	Frisbee
	Story of Sea Otters
	Silkworms
Jones	Television Magic
Jorgensen	A Guide to New England's Landscape
June	Chinese Kites
Kamien	What If You Couldn't...? A Book About Special Needs
Kastner	Sleep

EIGHTH GRADE I

Katan and Mintz	Hieroglyphics: The Writing of Ancient Egypt
Kavaler	Dangers of Noise
Keen	Be a Rockhound
	Beginner's Story of Minerals and Rocks
Kettlekamp	Hypnosis, the Wakeful Sleep
Kevies	Watching the Wild Apes [Goodall, Fossey, Galdikas]
Kiefer	Poisoned Land: Problem of Hazardous Waste
Knight	Comets
Kohl	View From the Oak
Kohn	Secret Codes and Ciphers
	Organic Living Book
	The Beachcomber's Book
Kraske	The Twelve Million Dollar Note
Kronzek	The Secrets of Alkazar
Kurten	The Cave Bear Story
Kuslan	Ham Radio: An Introduction to the World Beyond
Lasky	Tall Ships
Lauber	Earthquakes: New Scientific Ideas About How and Why the Earth Shakes
	Journey to the Planets
	Junior Science Book of Volcanoes
	Bats: Wings in the Night
Laycock	Beyond the Arctic Circle
	Strange Monsters and Great Searchers
Le Shan	What's Going to Happen to Me?
	Why Do I Feel This Way?
Leen	Snakes
Leister	Flying Fur, Fin and Scale
Lewis	Superstructures
Life	The World We Live In
Lindblom	The Fantastic Bicycle Book
Lindsay	Left-Handed Book
	Sleep and Dreams
Lozier	Model Making
MacClintock	Natural History of Giraffes

EIGHTH GRADE I

MacClintock and Mochi	A Natural History of Zebras
MacGregor	Skyscrapers: A Project Book
Macaulay	Castle
	Cathedral
	Unbuilding
	Underground
Manden	Great International Paper Airplane Book
Mannetti	Dinosaurs in Your Backyard
Marshall	The Story of Life
Massie	Chameleon Was a Spy
Math	Morse, Marconi and You
Math	Wires & Watts: Understanding and Using Electricity
Matteson	Draggerman
Mayall	Sky Observer's Guide
Mayer	Who's Out There?
McClung	America's Endangered Birds
	The Mighty Bears
	Amazing Egg
McDonald	Windmills
McFall	Wonders of Dust
McGough	Dollars and Sense: Teenage Consumer's Guide
McGowen	Album of Whales
	Album of Dinosaurs
	Album of Sharks
	Album of Astronomy
	Album of Prehistoric Man
	Album of Rocks and Minerals
McWhister	Guinness Book of Amazing Animals
Metos	Robots A to Z
	Exploring With Solar Energy
Meyer	The Bread Book, All About Bread and How to Make It
Meyers	Pearson, A Harbor Seal Pup
Michel	The Story of Nim: The Chimp Who Learned Language
Miles	Save the Earth

EIGHTH GRADE I

Milgrom	Adventures With a Paper Cup
	ABC Science Experiments
Milne, Lorus and Margery	Nature's Clean-Up Crew: The Burying Beetles
Miton	Here Comes the Robots
Moche	Search for Life Beyond Earth
	Star Wars Question and Answer Book About Space
Mochi	Horses as I See Them
Morgenstern	Metric Puzzles, Tricks and Games
National Geographic	Books for World Explorers Series
Navarra	Earthquakes
Northshore Rock and Mineral Club	Collecting Sites in and Around New England
Nourse	Fractures, Dislocations and Sprains
Olney	Keeping Insects as Pets
	They Said It Couldn't Be Done
Ommaney	Frogs, Toads and Newts
	Architecture: A Book of Projects for Young Adults
Ottewell	The Astronomical Companion, View from the Earth, 1983
Oxford	The Oxford Book of Economic Food Plants
Paul	Kids Gardening: A First Indoor Gardening Book
	Candies, Cookies, Cakes
	Simple Sewing
	Kids Cooking: A First Cookbook for Children
	Kids Outdoor Gardening
Pearl	Gems, Minerals, Crystals, and Ores: Collector's Encyclopedia
Pelham	Kites to Make and Fly: The Penguin Book of Kites
Perkins	Fannie Farmer Junior Cookbook
Perl	Junk Food, Fast Food, Health Food
Perry and Mersche	Journey Into a Hollow Tree
Peterson	Birds
Pinkwater	Superpuppy: How to Choose, Raise and Train
Piper	Story of Oil
Pluckrose	Small World Series

EIGHTH GRADE I

Pollard	How Things Work
Poynter	Zoo Lady: Belle Benchley and the San Diego Zoo
	Wildland Fire Fighting
Pringle	Lives at Stake: Science and Politics of Enviromental Health
	Nuclear Power: From Physics to Politics
	This Is a River
	Dinosaurs and Their World
	Discovering the Outdoors
	Discovering Nature Indoors
	In a Beaver Valley: How Beavers Change the Land
	Frost Hollows and Other Microclimates
	Vampire Bats
	Chains, Webs and Pyramids
	The Hidden World
	Only Earth We Have
	City and Suburb: Exploring an Ecosystem
	Water
	Nuclear Power
Rabinowich	Seals, Sea Lions and Walruses
	Kangaroos, Koalas, and Other Marsupials
Rahn	Seven Ways to Collect Plants
	How Plants Are Pollinated
	Watch It Grow, Watch It Change
	Grocery Store Zoology: Bones and Muscles
Rand, McNally	The International Atlas
Reich, Hill, and Wang	The World From Above
Rey	Find the Constellations
	The Stars: A New Way to See Them
Rich	Earth Movers
	Diesel Trucks
Rockwell	Wolves
Roever	Mustangs
Roth and Froelich	The Farm Book
Ruchlin	Bathtub Physics

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Rutland	Ships
Ryden	Wild Colt: The Life of a Young Mustang
Salvadori	Building: The Fight Against Gravity
Sander	The Curious World of Crystals
Sarnoff	Great Aquarium Book
Satchwell	Energy Series: Future Sources
Sattler	Dinosaurs of North America
Sawyer	Vibrations: Making Unorthodox Musical Instruments
Schaefer and Day	A Field Guide to the Atmosphere
Scheffer	The Seeing Eye
	Little Calf
Schick	Kongo and Kumba
Schlein	Giraffe: The Silent Giant
Schwartz	Earthwatch: Space-Time Investigations With a Globe
Scott	Loggerhead Turtle: Survivor for the Sea
	Moose
	Book of the Pig
	City of Birds and Beasts: Behind the Scences at the Bronx Zoo
Seixas	Living With a Parent Who Drinks Too Much
Selsam	Courtship of Animals
	Egg to chick
	How Animals Tell Time
	The Plants We Eat
	Land of the Giant Tortoise
Shapiro	Experiments in Anesthesia
Shebar	Animal Dads Take Over
Shelton	Geology Illustrated
Shepherd	Jellyfishes
Shostak	The Hydra
Shuttlesworth	Wildlife of Australia and New Zealand
	Animals That Frighten People: Fact Versus Myth
	Natural Partnerships: Story of Symbiosis
	Wildlife in South America

EIGHTH GRADE I

	Zoos in the Making
Silverstein	Circulatory Systems: The Rivers Within
	Muscular Systems
Simon	Snakes: The Facts and The Folklore
	Exploring Fields and Lots
	Look to the Night Sky
	The Optical Illusion Book
	Tropical Saltwater Aquariums
	Pets in a Jar
Soule	Mystery Monsters
Spinar	Life Before Man
Stanley	Easy to Make Electric Gadgets
Steichen	Family of Man
Stone	Chemistry of a Lemon
Stone	Chemistry of Soap
Strahler	A Geologist's View of Cape Cod
Taketazu	Fox Family: Four Seasons of Animal Life
Teleki	Goblin: A Wild Chimpanzee
Thompson	Crocodiles and Alligators
Thoreau	In Wildness Is the Preservation of the World
Thurman and David	The Magic Lantern: How Movies Are Made
Time-Life	Science Series
Vannini and Pogliani	The Color Atlas of Human Anatomy
Villiard	Reptiles as Pets
Wagenvoord	Flying Kites
Walther	A Spider Might
Waters	Crab From Yesterday
	Mysterious Eel
Webber	Bits That Grow Big
Webster	Science Projects With Eggs
Weyl	Men, Ants, Elephants
Wheat	Survival Arts of the Primitive Payutes
Whitney	Whitney's Star Finder
Weiss	Hammer and Saw: Introduction to Woodworking
	How to Be an Inventor
	Why Glass Breaks, Rubber Bends, Glue Sticks

EIGHTH GRADE I

	Motors and Engines and How They Work
Wentz	Paper Movie Machines
Wolberg	Zooming In: Photographic Discoveries
Woodside	What Makes Popcorn Pop?
Zappler	From One Cell to Many Cells
Zim	Waves
	Crabs
	Frogs and Toads
	Snakes
	The Universe
	Comets
Zim, ed.	Golden Field Guides:
	Birds
	Trees
	Flowers
	Insects
	Stars
	Mammals
	Sea Shore
	Shells
	Rocks and Minerals
	Fishes
	Reptiles and Amphibians
	Zoology
Zubrowski	Messing Around With Water Pumps and Siphons
	Messing Around With Drinking Straw Construction
	Messing Around With Water
	Messing Around With Ball Point Pens
	Bubbles: A Children's Museum Activity Book
	Ball Point Pens: A Children's Museum Activity Book

EIGHTH GRADE I

MAGAZINES

Animal Kingdom
Contact
Current Science
National Geographic
National Geographic World
Odyssey
Penny Power
Popular Science
Ranger Rick's Nature Magazine

APPENDIX

Some Famous Scientists and Inventors

Alexander Graham Bell - American inventor of the telephone
Archimedes - Mathematician in ancient Greece
Benjamin Banneker - American mathematician and amateur astronomer
Elizabeth Blackwell - First American woman to receive a medical degree
Margaret Burbridge - American astronomer
George Washington Carver - American agricultural chemist
Jacqueline Cochran - American astronomer
Nicholas Copernicus - Polish astronomer who realized the planets orbit the sun
Jacques Cousteau - French marine scientist, explorer, and author
Francis Crick - British biochemist, co-discoverer of the structure of DNA
Marie Curie - Polish born French physicist; helped discover radium & polonium
Charles Darwin - British naturalist; theory of evolution by natural selection
Charles R. Drew - American surgeon; developed blood bank
Amelia Earhart - American aviator; first woman to fly the Atlantic
Thomas Edison - American inventor in telegraph, electric lighting, photography
Albert Einstein - German-born American physicist; theory of relativity
Michael Faraday - British physicist and chemist; discovered benzene
Henry Ford - American automobile designer and manufacturer
Rosalin Franklin - English contributor to discovery of structure of DNA
Sigmund Freud - Austrian physician and neurologist; founder of psychoanalysis
Galileo Galilei - Italian astronomer and philosopher
Robert Goddard - American physicist; pioneering rocketry studies
Jane Goodall - American naturalist; studies of the behavior of chimpanzees
Johann Gutenberg - German inventor of movable type, printing press
William Harvey - British physician and anatomist; discovered blood circulation
Matthew Henson - American scientific explorer of the North Pole
Hippocrates - Ancient Greek physician
Earnest E. Just - American biologist
Johannes Kepler - German astronomer, physicist, and mathematician
Louis Leakey - British archeologist; discoverer of early human remains
Guglielmo Marconi - Italian electrical engineer; developed wireless telegraphy
Jan Matzeliger - American inventor of shoe last
Elijah McCoy - American inventor of automatic lubricator
Margaret Meade - American anthropologist, specialist in primitive cultures
Gregor Mendel - Austrian monk, founder of science of genetics
Maria Mitchell - American astronomer
Garrett Morgan - American inventor of the traffic light
Samuel Morse - American artist, promoter of the telegraph
Isaac Newton - British mathematician and philosopher; theory of gravity
Florence Nightingale - British nursing pioneer and hospital reformer
Louis Pasteur - French chemist; discoveries in immunology and microbiology
Cecilia Payne-Gaposchkin - American astronomer
Ellen Richards - American sanitary chemist
Charles Henry Turner - American biologist and educator
Leonardo da Vinci - Florentine artist and inventor
James Watson - American biologist; co-discover of the structure of DNA
James Watt - British inventor of the steam engine
Daniel Hale Williams - American surgeon; first open heart surgery
Granville Woods - American inventor of steam boiler furnace
Wright brothers - American inventors; first manned flight

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NOTES